Microcontroller Based Self-Maintained Aquarium Using PIC16F877 with Sensors

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Approval Sheet

Mapua Institute of Technology
School of EE-ECE-CoE

This is to certify that we have supervised the preparation of and read the design report prepared by **Von Arvie A. Barbosa, Christopher B. Barro, Joe Mark P. Esteban, Jan Michael E. Intia, and John Alex G. Villegas** entitled **"Microcontroller Based Self-Maintained Aquarium Using PIC16F877 with Sensors"** and that the said report has been submitted for final examination by the Oral Examination Committee.

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As members of the Oral Examination Committee, we certify that we have examined this design report, presented before the committee on **July 1, 2008**, and hereby recommended that it be accepted as fulfillment of the design requirement for the degree in **Bachelor of Science in Computer Engineering**.

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This practicum report is hereby approved and accepted by the School of Electrical Engineering, Electronics and Communications Engineering, and Computer Engineering as fulfillment of the practicum requirement for the degree in **Bachelor of Science in Computer Engineering (COE461D/C1)**.

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ABSTRACT

The design in this project showcases the implementation of a microcontroller based self-maintained aquarium. The aquarium, consisting of the microcontroller, LCD display, solenoid valve, relay, float switch, fluorescent lamp, filter, dechlorination liquid, and the LDR (Light Dependant Resistor), performed the following functions in the feeding, lighting, filtration, water replacement and dechlorination systems in the aquarium. Water Replacement depends on the alkalinity or acidity of the aquarium's water which is measured by the pH meter.

The design incorporates an energy supply that powers up the entire system of the *aquarium*. The system operates with the aid of the microcontroller, relay, solenoid valve and its sensors that help control the whole functions of the system. The design will also benefit the aquarist by maintaining the cleanliness of the aquarium and the feeding system of the fishes.

Keywords: Water replacement and dechlorination system, filtration system, microcontroller, pH meter, relay

Chapter 1

DESIGN BACKGROUND AND INTRODUCTION

I. The Research Setting or Frame of Reference

Maintaining a fish tank is very tiresome and costly. Keeping it clean is a major problem for aquarium owners because the water should be replaced periodically to keep it habitable for the marine creatures. Feeding is another problem especially for those who are busy with their work and find no time to feed their pets. Fishes require regular feeding or else they will die of starvation.

The aquarium is a living environment and therefore, some natural processes take place namely: Fishes excrete, plant leaves decay and uneaten foods rot. All these processes contribute to water contamination and because the aquarium is not affected by the cleaning effects of currents, flow and rain present in the wild, the water can quickly become turbid, harbor disease and poison the fish. These waste products also release ammonia. It is a known fact that even a small amount of this chemical will kill the fish.

There are effective ways of cleaning the water inside the aquarium. Firstly, test the acidity and alkalinity. Secondly, if it is acidic or basic, a part of the water should be gradually replaced because replacing all of the water at any point in time will change the water chemistry which will be stressful to the fish. Thirdly, how often and how much are basic factors to be considered in changing the water. It should depend on the waste load in tank size, and the sensitivity of the

fish. Monitoring the water quality with water tests is the best way to decide how often and how much water is to be replaced.

Finally, having a water filter will also solve the problem but keeping it always activated will disrupt the marine creatures. The vibration from the filter motor will stress the fish.

II. Review of Related Literature and Studies

Automation of Aquarium Systems

Several studies and literature were published regarding the automation of aquarium systems. An interesting article in the Fish Flash, entitled "Automated Water Changing", written by Bob Krampetz, explains how to construct a siphon/overflow water change system that does not involve drilling tanks. The author provided illustrations and a step-by-step procedure on how to implement a water replacement system. He used PVC and drip irrigation with valve to control the flow of water.

Equipment called "super feeder" is made to feed the fishes automatically. It has a base model that holds 3/4 cup of flakes or pellets, which can be increased with its supplied 2-cup hopper extension. It also has a special "Moisture Trap" funnel which effectively keeps excessive moisture away from the feeder's food reservoir as well as providing a means of distributing the food without spills. The feeder comes with a low voltage power adapter that can be plugged into any 24-Hr lamp timer, a digital timer (for precise timing), or even a home automation power module. Some people can operate it with a remote

control to manually feed the fish. It has its own internal electronic adjustable feed timer and volume adjustment to accurately adjust the amount of food you want to dispense per cycle (it drops the food all at once from a split second to over a minute for the amount of time you selected). The proponents believed that this equipment can also be used in the feeding system and in customizing the feeder box.

The Importance of Using pH Tests To Monitor Water Conditions

According to Kordon LLC, formerly Novalek Inc. formed by biological scientists in the California Academy of Sciences and Steinhart Aquarium, San Francisco, pH test is important for tropical marine conditions. The pH for tropical marine aquariums should be kept stable at 8.2-8.3. The most likely deviation in pH is going to be by the water becoming more acid as the aquarium water ages. To stabilize the pH, the aquarist should use water changes and/or pH buffers in the water to maintain the pH at 8.2-8.3.

For freshwater fishes, it is best to aim for a stable pH near neutral of about 6.8-7.2. Most freshwater fishes are raised, not wild caught, and are already adapted to this level of pH. What has become known over time, despite what their natural pH water conditions might have been, is that it is best to keep the pH stable, because even one tenth of a pH change is a doubling of pH on its logarithmic scale. This is a substantial change in acidity/alkalinity for the fish

and invertebrates in that water. As mentioned for marine aquariums, the proper pH can be maintained through water changes and/or using buffers that stabilize the pH, such as for freshwater at 7.0.

The researchers asked Professor Ariziel Ruth D. Marquez, a professor of Mapua Institute of Technology School of Chemistry and Chemical Engineering and she responded that the "ideal pH level of the water for the fishes to live is 6.6-7.3". When Professor Josephine A. Ng, a Chemical Engineer, was asked by the researchers about the accuracy of the pH level, she attested that the pH level stated was correct. In addition, a series of tests were made to prove the statement. Regular testing and monitoring the pH of water is highly recommended to ensure that the water inside the aquarium will not harm the marine creatures.

How water becomes Acidic or Alkaline

According to Brian Malinconico in his article from Aquarium-Wiki, Acidic or Alkaline is a term used by aquarists which refers to water conditions and its pH value. He states that water is said to be alkaline if it contains hydroxyl ions (OH). Hence, water with a pH higher than 7 is said to be an alkaline. Alkaline water can be high in calcium or magnesium ions. In a planted aquarium, the plants will give off carbon dioxide when the lights are turned off. This will make the water with less alkaline. The opposite of alkaline is acid. Some species of fish have difficulty breeding in alkaline water even though they can live quite happily in acidic

water. Neon tetras and Cardinal tetras are the most commonly known examples of acidic solutions. Typical alkaline living species of fish are Mollies and Platies. Keeping aquatic animals in the wrong side of their normal pH level will greatly shorten their average life expectancy. For example, keeping Neon tetras in a pH of greater than 7 will reduce their lifespan from an average of 20 years to only 2 or 3.

Change of pH level

The Marine Environment Protection Committee in its article, "Harmful Aquatic Organisms in Ballast Water", states that each species of fish has its own narrow range of pH preference and levels and outside of this range will cause health problems. For example, koi prefers a range between 7 and 8.5, while some tropical fishes prefer water that is slightly acidic. There are several ways that pH can affect fish health. High acidity or alkalinity can cause direct physical damage to skin, gills and eyes. Prolonged exposure to sub-lethal pH levels can cause stress, increase mucus production and encourage epithelial hyperplasia (thickening of the skin or gill epithelia) with sometimes-fatal consequences. Fish also have to maintain their own constant internal pH. Even small fluctuations of blood pH can prove fatal. Extreme external or water pH can influence and affect blood pH resulting in either acidosis or alkalosis of the blood. The other consideration is diurnal shifts in pH, mainly as a consequence of photosynthesis.

Large fluctuations (even though they may still be within the preferred range) are likely to be stressful and damaging to health of the fishes.

Effects of pH to the fish

According to Brooklands V.I.P Pet Products located in New Plymouth, in the province of Taranaki, New Zealand, pH-level in water is the measure of how much hydrogen is found in the water. Hydrogen is a chemical that is found all over the earth. The pH is a measure of the concentration of hydrogen ions in a solution or "the power of Hydrogen"

The pH scale ranges from 1(acidic) to 14 (basic). A change of one pH unit means a tenfold change in concentration. Some fish can tolerate a range of 5 to 9 pH. Other fish cannot tolerate a change in one pH unit.

Effects of pH on aquatic organisms:

- Affects breathing
- Cause stress, and diseases
- Affects the reproductive cycle of fish
- Affects the nitrogen cycle

Water replacement

In an article "Aquarium Basics: Partial Water Changes" by Haname, the writer states that aquarist should gradually replace the water if it is already acidic or basic. It states that the most frequent and most fatal mistake made by

beginners is to think that they need to "clean-up" the tank every now and then. It means to scoop up all the fish into a bucket, remove everything from the tank, give it all a good scrubbing, assemble everything back, and dump the fish back into the aquarium. If this happens the fish will be stressed and might die due to lack of oxygen.

Haname said that the good and consistent water quality is the single most important element of a healthy aquarium. To maintain water quality, a regular schedule of partial water changes is essential in most aquarium setups. Partial water change is so important (as opposed to total "clean-ups"), because it involves the concepts of Basic Aquarium Water Parameters and the Nitrogen Cycle.

The researchers asked Mr. Amador Domingo Jr., an aquarist who has been constantly growing different kinds of fishes regarding the partial change of water based on a regular schedule. He said that "for an average tank, water should be changed ¼ of the total volume of water in 24 hours". This was proven by a series of tests that were conducted on the design.

Basic Aquarium Water Parameters

Scott Charles in his article "Basic Aquarium Water Parameters", identified the basic parameters. 1.) The pH (Power of Hydrogen) is the measurement of hydrogen ions. Increased hydrogen ions (less bonding) results in a drop of the pH (more acidic water), while a decrease results in a pH rise. The pH is measured on a scale from 0-14. Changes in pH are common causes of fish

fatalities. Fish can adapt to most pH levels, if not broadly out of range, but they don't adapt well to bouncing values. In other words, a change in pH from 7 to 6 means 10 times more acidic water. A further drop to a pH of 5 equals 100 times more acidic water. If the aquarist wants to adjust the pH in the tank, he has to consider the carbonate hardness. The pH in harder water is more difficult to adjust because it bounces back. Keep in mind to change it slowly as it causes a lot of stress to the fish. 2.) General Hardness (GH) primarily measures calcium and magnesium ions. It is important for breeders (some species require very soft water, which is hard to maintain, requiring constant monitoring for maximum success). Other than choosing the right fish for the existing conditions, the GH is generally not all that important for the average hobbyist. 3.) Carbonate Hardness (kH) measures dissolved bicarbonate and carbonate ions. They are commonly referred to as the buffering capacity. The kH determines the pH stability and is therefore, very important. The more bond form, the higher the pH. Lesser carbonate ions results in a drop of pH. The kH of 70 ppm and less will initiate the pH crash. Therefore, never attempt to adjust these values unless it is absolutely necessary. Be sure to carefully monitor any changes in kH and pH. If the fish and tank are thriving, it is not recommended that any adjustments be attempted. 4.) Nitrogen compounds such as ammonia and Nitrite. Nitrates are well described in The Nitrogen Cycle article. 5.) Water companies add chlorine or chloramines as a disinfectant to tap water. Chlorine is less stable than chloramines and airs out in just a few days. Some persons simply let the water age for a couple of days

before doing the water change, thus, airing out the chlorine. When Chloramine is stable, it does not air out even if heavily aerated. As a mixture of ammonia and chlorine it passes through the fish's tissue directly into the bloodstream. In the blood, just like nitrite, Chloramine destroys the oxygen carrying cells and causes all fish to die within 24 hours.

The Nitrogen Cycle

In the article "Nitrogen Cycle" by Vanny Devos, Tiago Beltrão and Marcos Avila, they stated that if the pH reading is higher than 6.8, fish create ammonia as part of its biological processes. It is created by the decaying materials in the tank like uneaten food and dead plants. Ammonia in an aquarium has no place to go but into the water. It is a highly toxic chemical even in very small quantity. Bacteria is an aerobic creatures, which needs oxygen to survive. A group of bacteria known as nitrosonomas, break down the ammonia into nitrites. Similarly, nitrites are also lethal in small amounts, but not as small as ammonia and are also broken down by bacteria. This group of bacteria, known as nitrobacters, also requires oxygen to do its work. The nitrites get broken down to nitrates. Nitrates are not lethal except in extremely large amounts. There are only a few ways to regulate the amount of nitrate. Plants remove nitrate by using it as food. There is a type of bacteria (anaerobic) that will consume nitrate, but oxygen drives them away, and large amount of surface area is needed to be exposed to very slow moving water in order for them to work. Large amounts of

these bacteria are lethal to fish. The other way of removing nitrate is through water changes.

If the pH is lower than 6.8 and becomes stable at that point, ammonia is not an issue because the lower pH ammonia becomes ammonium. Ammonium is harmless except when in very large amounts. It is even easier for the plants to use them for food, and is unusable by the nitrifying bacteria.

Dechlorinator

Based from the article entitled "Dechlorination" written by Keith Seyffarth, a dechlorinator or chlorine remover is a chemical additive that neutralizes chlorine. Most municipal water supplies, and many holding tanks for wells in rural communities, farms, and ranches, are treated with chemicals to kill off any harmful bacteria or other pathogens which may get into the water. The most common of these chemicals are chlorine and chloramine. Though the dosages of these chemicals in the water supply are low enough that they are not harmful to a land animal (including people, dogs, cats, hamsters, horses, etc) or house plant, they are high enough to cause damage to the biological filter and eventually to the fish. For this reason, it is important to treat the water to remove chlorine with an appropriate dechlorinator before adding it to the tank. Good dechlorinators are dosed one drop for each 2 liters (0.5283 gallons). It is advised to treat only the new water being added to the tank; not the entire tank volume.

Dechlorinators are also generally very fast acting.These will neutralize the chlorine in a bucket of source water in a minute or two, and will also neutralize chloramine in five minutes. According to "Bio Research" the amount of dechlorination that should be dispensed is 5 drops per gallon.

Fish foods

An article regarding fish foods was also taken into account. It is written by Nathan Miller, entitled "Aquarium Fish Food Tips". This article provides useful information regarding the different kinds of food for the fishes. The author grouped fish foods found in major aquarium shops into two categories: flake foods, and freeze-dried foods. These foods provide a complete and balanced diet for the fish and are available in a variety of forms: floating pellets, sinking pellets, granules, tablets, and flakes.

- Flakes are the most common type of processed foods, and are available in a very wide variety. Some flakes are prepared to provide the nutritional requirements of specific varieties or species of fish, and others are designed to counter nutritional imbalances, while still others are balanced to enhance color or growth or to encourage spawning.
- Pellets are available in forms that are denser or lighter than water. This allows the fish to feed in a more natural way - if the right pellet is provided. Some fish prefer to feed off the bottom of the tank while others

prefer to feed off the surface. Like flakes, pellet foods are available in many varieties, each with a specific purpose.

- Granules are like very small, hard flakes or tiny pellets. Currently, only a limited variety of fish food granules are available, usually prepared for the general nutritional needs of small community fish.
- Tablets are large flat pellets. Most tablets are of a sinking variety, but there are some that cling or sink to the side of the aquarium so that the aquarist may observe the fish being fed. Most of the sinking tablets provide the nutritional needs of scavengers and bottom feeders.

Feeding according to the Weight of fish

According to Matsushima Y., goldfish has a weight average of 60g. It must be fed only 4% of its body weight daily. An average of 12-14 pellets is sufficient for feeding a goldfish in one day. Fishes are opportunistic feeders. When an excess of food is offered, they will produce more wastes and feces partly due to incomplete digestion of protein. Overfed fishes are sometimes recognized by feces trailing from their cloaca. They should be fed as much food as they could consume in one to two minutes, and no more than three times a day. Extreme overfeeding can be fatal that may result to bursting of the intestines. Novice fish keepers who have newly purchased fish need to watch them carefully for a few days, as it is important to know how much the fish will eat in a couple minutes of time and if they do not eat they will die in 4-8 days.

pH meter and Litmus paper water test

According to Sandy Delisle and Perry Romanowski in their article "Litmus Paper", the litmus paper is used to test whether a solution is acidic or alkaline. It is the most recognized member of chemical indicators. Litmus changes color when exposed to an acidic or basic solution. The simple pH scale ranges from 0-14 with 0 being the most acidic, 7 being neutral, and 14 being the most basic or alkaline. They are both effective at indicating whether a substance is acidic or basic because it cannot report an exact numerical pH value. Universal indicators or pH meters are used for this purpose. Universal indicators are composed of a variety of materials, each changing different colors at different pH values which allows the observer to determine more precisely where the solution in question falls on the pH scale. Universal indicators can be impregnated onto paper and made into pH paper or they can be used in the liquid form.

A reference color card is provided with each universal indicator that correlates a particular color with a pH range. Generally speaking, most universal indicators are accurate within two values on the pH scale. For example, a green result could indicate a pH from 8-9. This means universal indicators can determine the pH of a sample quantitatively within a certain range.

Microcontrollers

According to Brain, Microcontrollers are special purpose computers (2000). A typical low-end microcontroller chip might have 1,000 bytes of ROM

and 20 bytes of RAM on the chip, along with eight I/0 pins. The characteristics of a microcontroller are as follows:

- Microcontrollers are "embedded" inside some other device (often a consumer product) so that they can control the features or actions of the product. Another name for a microcontroller, therefore, is "embedded controller."
- Microcontrollers are dedicated to one task and run one specific program. The program is stored in ROM (read-only memory) and generally does not change.
- Microcontrollers are often low-power devices. A desktop computer is almost always plugged into a wall socket and might consume 50 watts of electricity. A battery-operated microcontroller might consume 50 milliwatts.
- A microcontroller has a dedicated input device and often (but not always) has a small LED or LCD monitor for output. A microcontroller also takes input from the device it is controlling and controls the device by sending signals to different components in the device.
- A microcontroller is often small and low cost. Its components are chosen to minimize size and to be as inexpensive as possible.

In contrast to general-purpose CPUs, microcontrollers do not have an address bus or a data bus, because they integrate all the RAM and non-volatile

memory on the same chip as the CPU. Because they need fewer pins, the chip can be placed in a much smaller, cheaper package. By integrating the memory and other peripherals on a single chip and testing them as a unit increases the cost of that chip, but often results in decreased net cost of the embedded system as a whole. Even if the cost of a CPU that has integrated peripherals is slightly more than the cost of a CPU plus external peripherals, having fewer chips typically allows a smaller and cheaper circuit board, and reduces the labor required to assemble and test the circuit board.

Float Switch

Based from the article in wikipidea, a float switch is a device used to sense the level of liquid within a tank. The switch may actuate a pump, an indicator, an alarm, or other devices.

A very common application is in sump pumps and condensate pumps where the switch detects the rising level of liquid in the sump or tank and energizes an electrical pump which then pumps liquid out until the level of the liquid has been substantially reduced, at which point the pump is switched off again. Float switches are often adjustable and can include substantial hysteresis. That is, the switch's "turn on" point may be much higher than the "shut off" point. This minimizes the on-off cycling of the associated pump.

Some float switches contain a two-stage switch. As liquid rises to the trigger point of the first stage, the associated pump is activated. If the liquid will

continue to rise, perhaps because the pump has failed or its discharge is blocked, the second stage will be triggered. This stage may switch off the source of the liquid being pumped and may trigger an alarm or both.

Transformer

According from the article in wikipidea, transformers are some of the most efficient electrical 'machines', with some large units that can transfer 99.75% of their input power to their output. Transformers come in a range of sizes from a thumbnail-sized coupling transformer hidden inside a stage microphone to huge units weighing hundreds of tons used to interconnect portions of national power grids. All operate with the same basic principles, though a variety of designs exist to perform specialized roles throughout home and industry.

A key application of transformers is to increase voltage before transmitting electrical energy over long distances through wires. Most wires have resistance and therefore, dissipate electrical energy at a rate proportional to the square of the current through the wire. By transforming electrical power to a high-voltage (and therefore low-current) form for transmission and back again afterwards, transformers enable economic transmission of power over long distances. Consequently, transformers have shaped the electricity supply industry, permitting generation to be located remotely from points of demand. All but a fraction of the world's electrical power has passed through a series of transformers by the time it reaches the consumer. They are used extensively in

consumer electronic products to step down the supply voltage to a level suitable for the low voltage circuits they contain. In these kind of applications, the transformer may also act as a key safety component that electrically isolates the end user from direct contact with the potentially lethal supply voltage.

Signal and audio transformers are used to enhance the stages of amplifiers and to match devices such as microphones and record player cartridges to the input impedance of amplifiers. Audio transformers allowed telephone circuits to carry on a two-way conversation over a single pair of wires and to couple a differential-mode signal to a ground-referenced signal, and to isolate external cables and internal circuits.

III. The Conceptual Framework

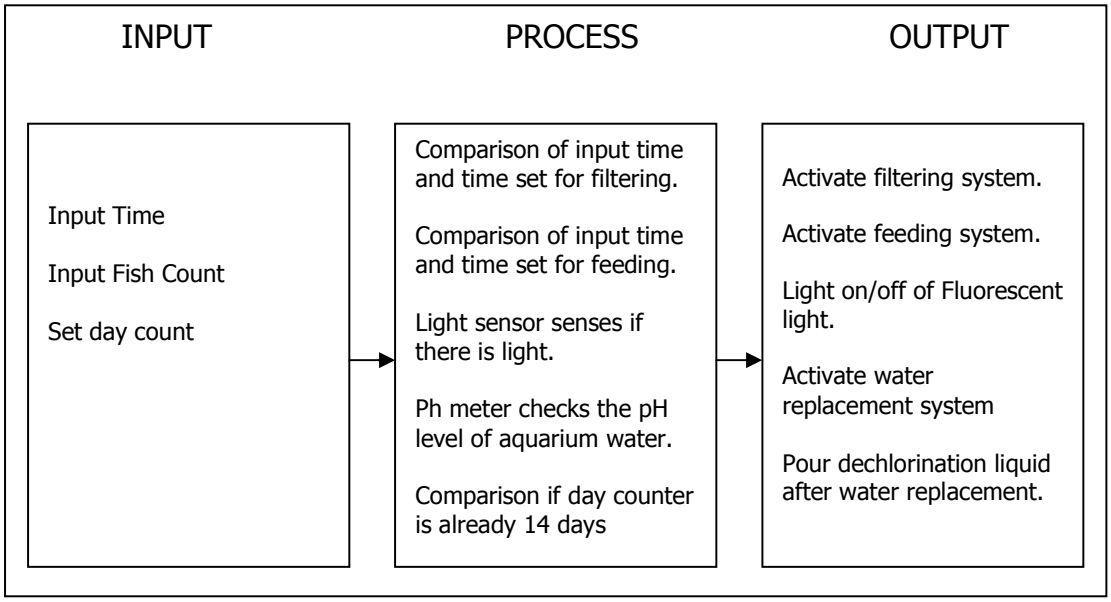

INPUT
PROCESS
OUTPUT
Input Time
Input Fish Count
Set day count
Comparison of input time and time set for filtering.
Comparison of input time and time set for feeding.
Light sensor senses if there is light.
Ph meter checks the pH level of aquarium water.
Comparison if day counter is already 14 days
Activate filtering system.
Activate feeding system.
Light on/off of Fluorescent light.
Activate water replacement system
Pour dechlorination liquid after water replacement.

Figure 1: Conceptual Frame Work

There are a lot of factors to be considered when designing a self-maintained aquarium system such as water quality, fish populations, physical size of the aquarium, and the kinds of fishes inside the aquarium.

Water quality is a general term that refers to several categories such as: physical and chemical characteristics, pollutants and contaminants (toxic chemicals, petroleum derivatives), and biological agents, like water-borne disease organisms. Each of these categories includes a set of parameters used to measure and describe the degree of quality of each. Some of these parameters may include water temperature, pH level, and dissolved oxygen. Water quality of the aquarium affects the system in a way that it determines whether the water needs to be filtered or replaced. Fish population may affect water quality. An overpopulated aquarium system may lower the dissolved oxygen which might cause serious problems to the health of the fishes.

The physical size of the aquarium could determine the number of fishes that could live in it. Small containers may not be healthy for certain types of fishes and may cause overpopulation. In addition, it is important to consider the kinds of fishes that will stay in the aquarium because some of them have characteristics that might cause trouble with some other inhabitants. Is is also possible that some of these fishes may not be supported by the automatic feeder. Refer to Figure 1 for the complete process of the system.

IV. Statement of the Problem

The main problem of the design is how to maintain the cleanliness of the aquarium and to feed the fishes automatically so that the aquarist will not be burdened of the feeding routine.

Specifically, the study seeks to answer the following:

1. How to effectively filter the water and to dispose the solid wastes in the water;
2. How to detect the acidity and to alkalinity of water;
3. How to drain and to replace water without hurting the fishes;
4. How will the lighting system work;
5. How to pour the dechlorination liquid after replacing water; and
6. How to feed the fish.

V. Objective of the Design

The main objectives in the implementation of the design are: to make an aquarium that will lessen its maintenance, to retain the clean environment of an aquarium using advanced devices, and to automatically control the food supply of the fishes through the use of a self designed container controlled by a dc motor.

Specific Objectives:

In order to fulfill these objectives, this study seeks to meet the following:

1. Test accurately the time of filtering the water using pump motors and to dispose its solid wastes;
2. Detect the pH level of the water using a pH sensor;
3. Drain and replace the water once the water becomes acidic or basic as monitored by the pH sensor;
4. Have a lighting system dependent on the LDR;
5. Dispense dechlorination liquid after the water is replaced; and
6. Automatically feed the fish.

VI. The Significance of the Design

This project will greatly benefit the fish enthusiasts by maintaining a clean environment for the fish and by providing a safer habitat for the aquarium creatures. It will also benefit those people who go on long trips or those who just have no time to clean their aquarium and feed the fish because they will not worry about the safety of their fishes.

VII. The Scope and Delimitation

The scopes of the research design are the following:

1. Filtering the water is set to a series of exact time with 4 hours interval although filtration lasts 2 hours. Therefore, it will take a total of 6 hrs before the filter system will work again.

2. An automatic feeding machine will accompany the automatic water filter. The automatic feeder will disperse fish food periodically. It has a self designed container which can dispense about 6 – 7 pellets per fish and it also dispenses food according through the number of fish entered by the user.
3. The pH meter will read the pH level of the water and will determine if it is neutral, acid or base. If the water is detected to be acidic or alkalinity, the water replacement process will be initiated. Then, the dechlorination will follow to ease the chlorine in the aquarium.
4. The motor pump will drain ¼ of the total volume of water in the aquarium. There will be two float switches that determine the maximum and the minimum water level. Solenoid valve will be used in controlling the flow of the water in the hose.
5. There will be one power supply source where all the devices inside the aquarium are plugged in. It is installed at the back of the aquarium.
6. There will be a fluorescent lamp inside the aquarium that is covered by a stainless steel box. It will automatically turns OFF if a light sensor detects another light coming from any direction and turns ON if it doesn't.
7. If within 2 weeks the pH meter does not detect the water to be too basic or too acidic, the water will still be drained to ¼ level and be replaced because it is recommended by aquarium users.

The delimitations of the design are the following:

1. The design was limited to the classification and kind of fishes suitable inside the aquarium's environment. The quantities of fishes that can be put inside the aquarium were also limited so as to prevent overpopulation that may cause problems to the health of the fishes. Although the design is for fishkeeping, the researchers only chose one type of fish, the goldfish because it can withstand variations in pH much better than other fishes.
2. In terms of its automatic dechlorination system, it was limited through a fixed number of drops that the storage container could handle. It has to be refilled manually when empty for it to release dechlorination liquid again. This only happens through a series of dispensing.
3. The fishes in the aquarium were limited to those pellet-eating species. Based on the pH that is maintainable by the aquarium design, the best type of fishes that can only be placed inside the aquarium are freshwater fishes.
4. For filtering, the filter were activated only four times a day.
5. For the feeding of the fishes, it was limited for fishes that eat two times a day and 12 to 14 pellets a day.
6. The design did not measure the temperature of the water which could also be a factor in maintaining the safety of the fish in the aquarium.

7. The light dependent resistor (LDR) did not measure a specific value of light intensity to be activated.
8. The dissolved oxygen level of the water was not considered.

VIII. Definition of Terms

The definition of the terms in this section was taken from wikipedia, the free encyclopedia, http://www.wikipedia.com:

Aquarium is a glass-sided tank, bowl, or the like, in which fish or other living aquatic animals or plants are kept.

Filter is a device used in the aquarium to block certain objects or substances while letting others through. Filters are often used to remove harmful substances from water.

Aquarium fish feeder is electric or electronic gadget that is designed to feed aquarium fish at regular intervals. It is often used to feed fish when the aquarist is on vacation or is too busy to maintain a regular feeding schedule.

Feeder is a boxlike device from which animals may eat. This device is designed to allow a number of fish to feed simultaneously or to release a specific amount of feed at regular intervals.

Photo resistor is an electronic component whose resistance decreases with increasing incident light intensity. It can also be referred to as a light-dependent resistor (LDR), or photoconductor. It is made of a high resistance semiconductor. If the light falling on the device is of high frequency, photons absorbed by the semiconductor give electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conducts electricity, thereby, lowering resistance.

Sensor is a mechanical device sensitive to light, temperature, radiation level, or the like, that transmits a signal to a measuring or control instrument. It is a device which measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument.

Relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. Since relay can control an output circuit of higher power than the input circuit, it can be considered an electrical amplifier.

Microcontroller or MCU or µC is a computer-on-a-chip type of microprocessor emphasizing high integration, low power consumption, self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor (the kind used in a PC). In addition to the usual arithmetic and logic elements of a general purpose microprocessor, the microcontroller typically integrates additional

elements such as read-write memory for data storage, read-only memory, such as flash for code storage, EEPROM for permanent data storage, peripheral devices, and input/output interfaces.

PIC Microcontroller is a family of Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1640 originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "Programmable Interface Controller", but shortly, thereafter, was renamed "Programmable Intelligent Computer".

Proton PIC Basic is Software that provides a functional PIC assembly code allowing emulation of commands available with the BASIC stamp, directly with the PIC microcontroller, and in assembly language. The compiler accepts a BASIC language to be compiled into a HEX file be burned into the microcontroller.

PROTEUS ISIS is circuit simulation software designed to build and test schematic diagrams. It is also used for PCB lay outing, circuit designing and real-time circuit simulation. Interactive peripheral models, CPU models and virtual instruments can be employed in the designing of circuits.

Chapter 2

METHODOLOGY

Design Methodology

The researchers used the experimental method of research in testing the prototype. They used experimental research for the materials needed and the construction of the hardware for automation. They also carefully analyzed what materials will be used or suited in the aquarium. In addition, they researched on the sensors and other components for the controller. Figure 2 shows the Process Flowchart of the design.

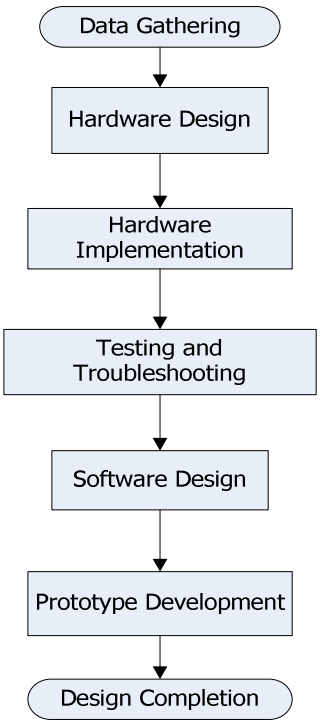


Figure 2: Process Flowchart

The research group gathered all the data needed and maximized the materials required for the aquarium. They also researched in the internet

regarding the best environment needed for the maintenance of a clean and safe aquarium and the sensors and other components needed for the hardware part of the design.

After the first assignment, the group inquired about and found the material to be used at Bio Research, a pet shop located on SM Mega Mall, and other local pet shops. The researchers requested the pet shop managers to share their expertise and knowledge on pertinent information about aquarium fishes.

With the abovementioned components of the aquarium, the group proceeded on how to automate and to keep the environment clean and livable for the fish inside. They did not only inquire at Alexan and E-Gizmo for the hardware to be used in the automation of the design but also for creating the code and PCB making software.

Design Procedure for Actual Design

Hardware Design

List of Materials

The following lists of materials were acquired from Bio Research and local pet shops for the aquarium components, and e-Gizmo and Alexan for the circuit components. Refer to Table 1 for list of materials.

	Component Name	Quantity
Aquarium Components		
	Aquarium (10 gal)	1 pc.
	Filter	1 pc.
	Pump	1 pc.
	Float Switch	2 pcs.
	Solenoid Valve	1 pc.
	Holder	2 pcs.
	Flourescent Light w/ Aluminum Casing	1 pc.
	pH meter	1 pc.
	Syringe	1 pc.
Main Circuit		
	PIC16F877	1 pc.
	BA6219B	4 pcs.
	DC Motor	2 pcs.
	LCD 4x20	1 pc.
	Button	4 pcs.
	Relay	2 pcs.
	Solid State Relay	4 pcs.
	Crystal (4MHz)	1 pc.
	7805	1 pc.
	10K 1/4W Resistor	12 pcs.
	1K Resistor	8 pcs.
	220 Resistor	7 pcs.
	100K Resistor	2 pcs.
	4.7K Resistor	1 pc.
	150 Resistor	1 pc.
	22pF Capacitor	2 pcs.
	0.01uF Capacitor	1 pc.
	3mm LDR	1 pc.
	DC Socket	1 pc.
	PCB 4x2	5
	IC Holder (40 pins)	1 pc.
	AC Cord	1 pc.
	Diodes	15 pcs.
	Transformer	2 pcs.
	AC Outlet	4 pcs.
Miscellaneous		
	Male/Female Header	19 pcs.
	Shrinkable Tube (2mm)	1 meter
	Ferric Chloride	2 bottle
	Filter Foam	1 pc.
	Terminal Block	5 pcs

Table 1: List of Materials

Hardware Component

Microcontroller - PIC16F877

The PIC16F877 microcontroller was used for the main functions of the aquarium. It controlled the activation of every function according to the program that was coded and embedded. The output ports of the microcontroller were connected to the functional components of the aquarium which are the: motor pump, compact fluorescent lamp, filter, feeder and dechlorination.

The output of every function was controlled by the hard coded program of the microcontroller. Output will also be dependent on the input of time, fish count, and day counter that is settable by the user. Refer to Appendix A, for the figure.

LCD - Hitachi HD44787A (4x20)

The LCD used is Hitachi HD44787A. The size 4x20 is second to the smallest available in the market. It will be sufficient for the display of information needed by the user. This will display the important information about the functionalities of the aquarium like the pH value, the time, and the functions that are currently working. For the figure, refer to Appendix C.

Solenoid Valve – 2/2 way Solenoid Valve 220 size ¼”

A solenoid valve is a general purpose, one input, one output, two state (open/close) solenoid valve that runs on 220V. It was used as a control component for the input of water. It was controlled by a relay that accepts a 6V from the microcontroller to route the power source of the valve. Solenoid valve will be deactivated by the float switch if the lower float switch gives a high value. The valve starts refilling the aquarium as expected.

Relay – SPDT

Furthermore, the relay that the researchers used is a single push double throw variety. It will accept a 6V DC of input and will output a 220V AC. Relays were used to activate the solenoid valve, filter, pump and florescent lamp for they only run on 220V.

The SPDT relay acts as a switch for the feeder motor and dechlorination motor. As soon as the microcontroller gives the signal to activate the function, It transfers the 220 volts needed to activate these motors. Refer to Appendix F for the figure.

Float Switch

The float switch closes or opens its circuitry depending on the water level. Two float switches were used; one for controlling the draining of water and the other for controlling the pouring of water into the aquarium.

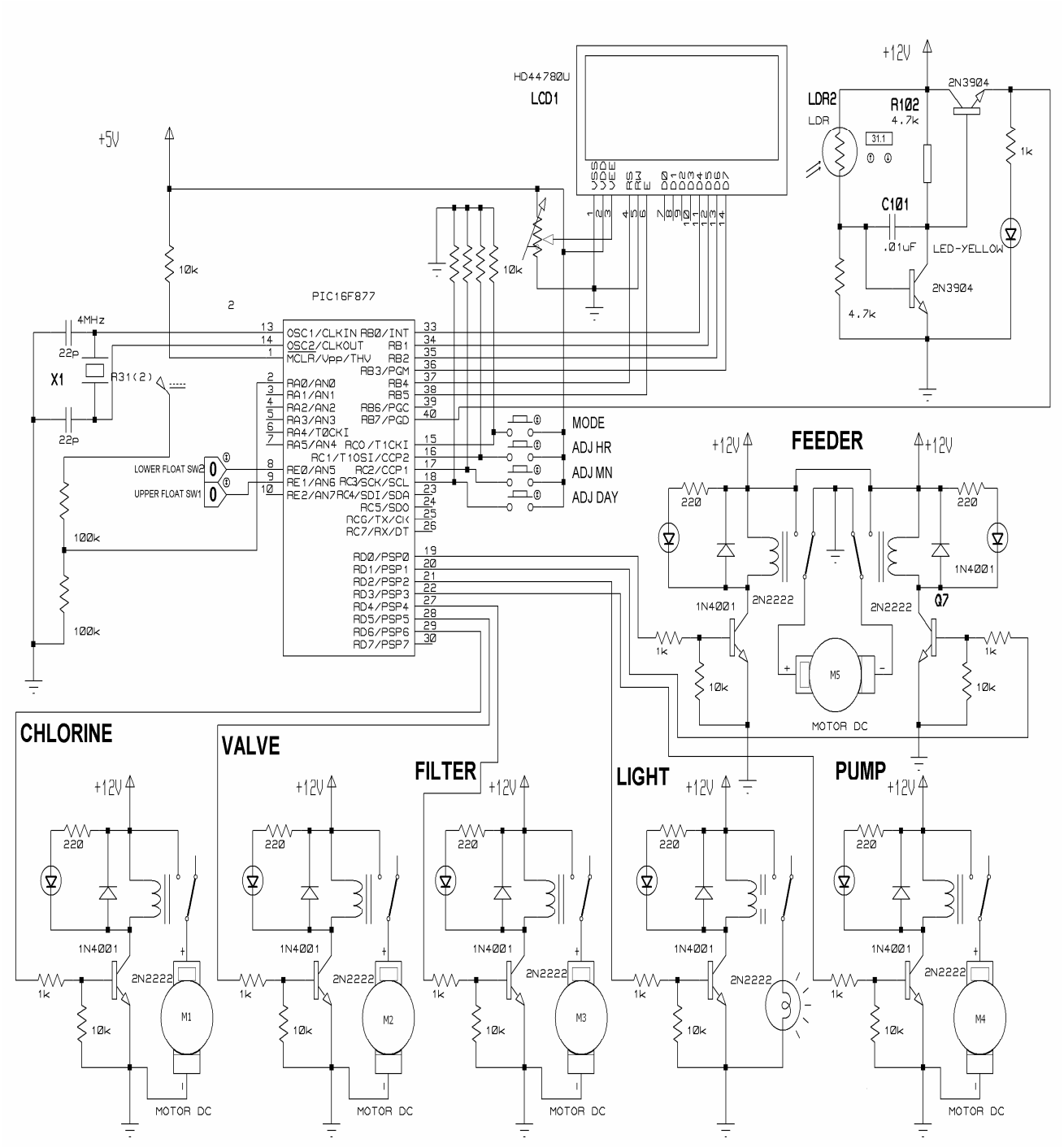
The float switch will give a value of high if the lower switch is activated. This will stop the pump motor from draining the water. After this, the solenoid valve will start to pour water into the aquarium. The higher float switch will give a high value if the water reached the maximum level of water and will stop the solenoid valve from pouring.

LDR (Light Dependant Resistor)

The LDR resistance varies from the light it absorbs on its surface. It will be used as the sensor for triggering the fluorescent light. It gives a value of high to the microcontroller if it sensed that the environment of the aquarium is dark and a value of low if there is light that the LDR sense. Normally, the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically. When the light level is low the resistance of the LDR is high and its resistance falls and current flows into the base of the first transistor and then the second transistor. This tends to activate the fluorescent light. However, when the light shines onto the LDR it prevents current from flowing to the base of the transistors which does not trigger the fluorescent light to activate.

The preset resistor can be turned up or down to increase or decrease resistance, in this way it can make the circuit more or less sensitive. It can be changed to achieve the desired effect although any replacement must be at least 1K to protect the transistor from being damaged by excessive current.

Circuit Design



The circuit is designed in ISIS software.

Figure 3: Circuit Diagram

Hardware Implementation

Building the circuit with a software

The circuit was designed and tested on ISIS; software was designed for building and testing schematics. The circuit could also be used to simulate and to test the code of tune and check if it works. And, considered the datasheet and pin configuration of the different IC and components. Refer to Appendix B for the reversible motor driver, Appendix D for voltage regulator, Appendix E for crystal oscillator and Appendix F for SPDT relay switch.

Implementation on Breadboard

The implementation of the circuit on a breadboard was done to ensure the function of the modules in the circuit to perform according to plan before mounting it on a PCB. This was done to avoid the reiteration process of implementing it in the PCB. Refer to Figure 3, for the complete circuit diagram.

Implementation on PCB

After testing rigorously the circuit on the breadboard, the design was implemented on PCB. The process was done first by etching the PCB circuit, done in PCB designer software, on the PCB, then drilled the necessary holes for the mounting of components. Lastly, was soldering the materials on the PCB. Refer to Figure 3, for the complete circuit diagram.

Testing and Troubleshooting

Testing the routes and connection of components on the PCB was utmost necessary. This would ensure that the component was the source or fault of the problem during troubleshooting. Testing was done to ensure that no connections were loose and connected unintentionally.

After testing, the research team started troubleshooting. It was done by having a live system and checked if the input, output, sensors and other components if the system worked well. Refer to Appendix G, for the schematic diagram and Appendix I for the User's Manual.

Software Design

Software Component

The software used in the design were ISIS, PCB Designer, Proton PIC Basic (PPB) and Parallel Port PIC Programmer. Such software were used for different types of jobs:

ISIS was used for schematic designing and circuit testing. It was also used to simulate the code made in PBP. It eased the job of burning the code on the microcontroller and testing it in that way. PCB Designer was also used to create the PCB connections of the circuit. After designing the PCB connections, the design was etched in the PCB. Proton PIC Basic or PPB was the compiler used in the design. The BASIC language compiled the code into a HEX file. The HEX file was then ready to burn/program into the microcontroller. It was done by

using of Parallel Port PIC Programmer. Refer to Appendix H, for the program and Figure 4, for the system flowchart.

System Flowchart

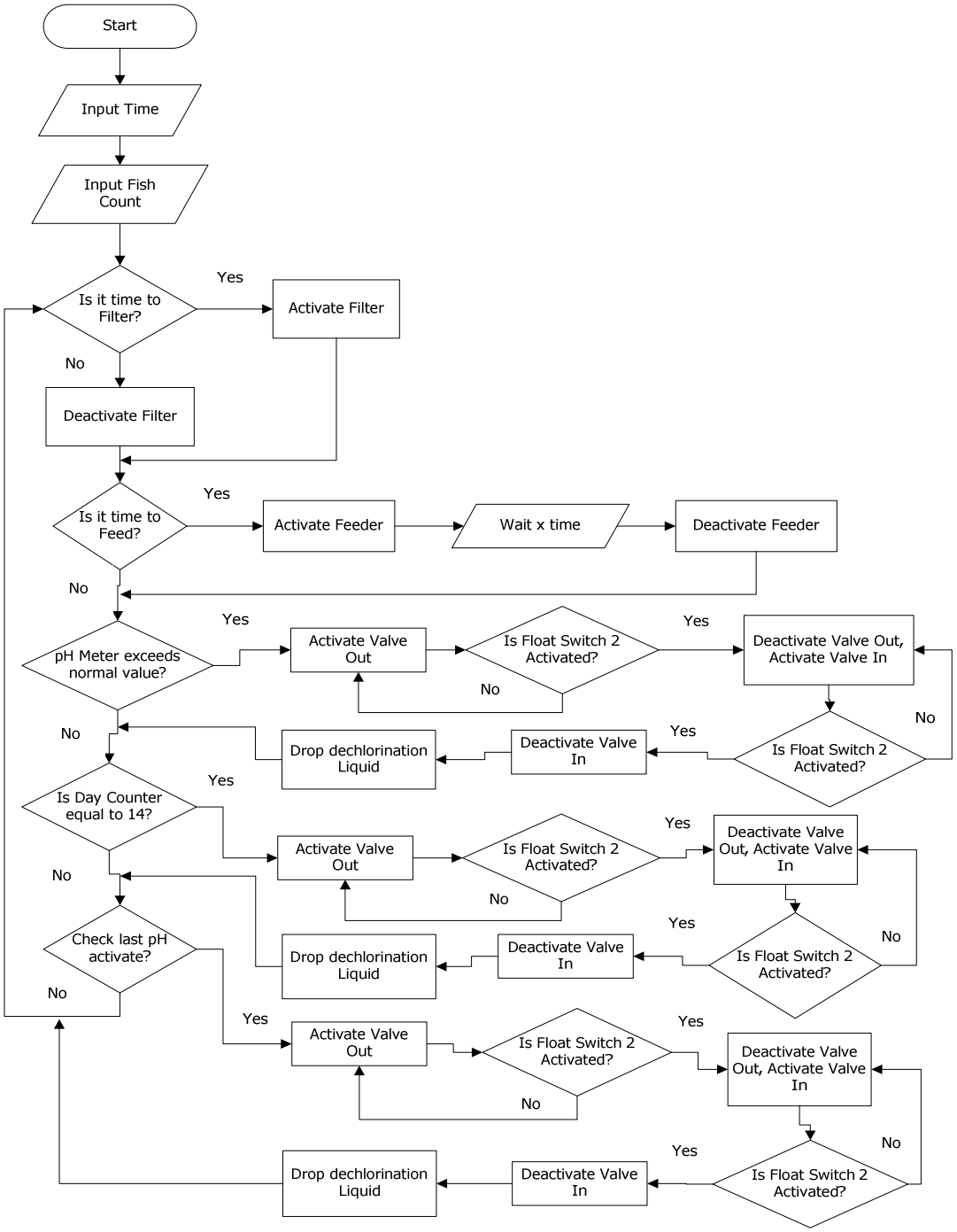


Figure 4: System Flowchart

Prototype Development

The first step on building the design was gathering the materials needed for the hardware. The materials needed were: sensors, input buttons, output display, microcontroller, etc. After computation of the materials needed, the team inquired at Alexan and E-Gizmo for the availability and cost of the materials needed.

To complete the hardware implementation, the researchers constructed the circuit first in ISIS. After identifying the correct pins to be used in the design, they assembled the gathered materials in a breadboard to test and simulate the code. Putting components in a breadboard was a rigorous task. To check if the connecting wires were properly connected, they rechecked if it was in the right pin of the IC. Even so, it was done to make the modification early in the design. If some circuits were weak, it was immediately fixed here to avoid the repetition of the succeeding processes. After checking the system they proceeded to build the PCB circuit and designed the PCB circuit in PCB designer. The next process was etching the PCB circuit in the copper board using ferric chloride. When the circuit emerges they drilled the holes for mounting the components onto the board. Soldering the component was done to ensure the proper connectivity of each component. It was necessary to test the connectivity of each component in the circuit after soldering. If an improper solder or cold solder onto the board were done the researchers de-soldered and soldered it again. After testing the

soldered components, troubleshooting the system was done next. To troubleshoot easily, they did them part by part or by modules. Later, they troubleshoot the LCD of the system to test if it worked well. Then, the research team tested the relays connected in the microcontroller to easily identify what went wrong on the circuit. Refer to Appendix G, for the schematic diagram.

Parallel to the construction of the hardware was building the software or the code that were used in the microcontroller. The researchers used the compiler PIC Basic Pro which accepts a BASIC language that would be compiled into a HEX file and would be burned into the microcontroller. While the components were being mounted on the breadboard, the software can be tested in ISIS. Refer to Appendix H, for the source code.

Chapter 3

PRESENTATION AND INTERPRETATION OF DATA

This chapter deals with the presentation, analysis and interpretation of data that were obtained by the researchers while conducting a series of tests and studies on the development of the prototype.

Test of Accuracy and Reliability

The accuracy and reliability of the design were tested by observing the filtration, pH level, automatic feeder, water replacement system with dechlorination liquid, and Lighting system.

In testing the accurate time of filtering, the time was set to 6:59AM for the first test when the clock struck at 7:00AM. The filter device was triggered to filter the water. The filtration duration was set to activate for 2 hours, therefore, it stopped at exactly 9:00AM. The filtration of aquarium water must activate four times a day which are stated in Table 2. The test results should verify if the water was filtrated or not. Three actual testing days were conducted to perform the accuracy and reliability testing of the filtration system. Table 2 below summarizes the results of the accuracy testing.

Day	Time	Water Filtrated	Filtering Duration
1	1:00 – 3:00	Yes	2 hours
	7:00 – 9:00	Yes	2 hours
	13:00 – 15:00	Yes	2 hours
	19:00 – 21:00	Yes	2 hours
2	1:00 – 3:00	Yes	2 hours
	7:00 – 9:00	Yes	2 hours
	13:00 – 15:00	Yes	2 hours
	19:00 – 21:00	Yes	2 hours
3	1:00 – 3:00	Yes	2 hours
	7:00 – 9:00	Yes	2 hours
	13:00 – 15:00	Yes	2 hours
	19:00 – 21:00	Yes	2 hours

Table 2: Accuracy Test Results of Filtration System

Table 3 summarizes the results of the reliability testing of the filtration system. If water was filtrated from the time it started filtering the water to the time duration configured in the microcontroller, success was indicated. Otherwise, failure was indicated in the test.

Day	Time	Filtering Duration	Test Result
1	1:00 – 3:00	2 hours	Successful
	7:00 – 9:00	2 hours	Successful
	13:00 - 15:00	2 hours	Successful
	19:00 – 21:00	2 hours	Successful
2	1:00 – 3:00	2 hours	Successful
	7:00 – 9:00	2 hours	Successful
	13:00 - 15:00	2 hours	Successful
	19:00 – 21:00	2 hours	Successful
3	1:00 – 3:00	2 hours	Successful
	7:00 – 9:00	2 hours	Successful
	13:00 - 15:00	2 hours	Successful
	19:00 – 21:00	2 hours	Successful

Table 3: Reliability Test Results of Filtration System

In testing the accuracy of the automatic feeder system, the feeding time was set after the 2nd and 4th full filtration, which was on 9:00 and 21:00 everyday. The feeder would release 6 to 7 pellets per fish and each dispense will depend on the number of fish inputted on the system. It used pellets which weigh 170mg each. With an average of 6 to 7 pellet drops per feeder action, daily feeding requirement for the goldfish was adequate as stated in an article "Feeding according to the Weight of the Fish" by Matsushima from page 12. The

feeder box was responsible for the dispensing of the pellets. Three actual testing days were conducted to perform the accuracy and reliability testing of the feeding system. Table 4 summarizes the results of the accuracy testing.

Day	Time	Feeder Action	No. of fish	No. of Dispensing
1	9:00	Open	1	1
	21:00	Open	1	1
2	9:00	Open	3	3
	21:00	Open	3	3
3	9:00	Open	4	4
	21:00	Open	4	4

Table 4: Accuracy Test Results of Feeding System

Table 5 summarizes the results of the reliability testing of the feeding system. The compared number of dispense was equal to the number of fishes inside the aquarium, and if the dispensed feeds were dispensed on the set time, success would be indicated. Otherwise, failure is indicated in the test.

Day	Time	Feeder Action	Results
1	9:00	Open	Successful
	21:00	Open	Successful
2	9:00	Open	Successful
	21:00	Open	Successful
3	9:00	Open	Successful
	21:00	Open	Successful

Table 5: Reliability Test Results of Feeding System

The accuracy of the pH meter was tested with the use of a litmus paper, pH paper and sample items with different pH levels. The researchers compared the reading of the pH sensor to the color value of the pH paper depending on the pH level of the sample items if it was acidic, neutral or basic. One actual testing of acidic, neutral and basic water was conducted to perform the accuracy and reliability testing of the pH meter. According to Engr. Priscila N. Tagala, formerly a Che-Chm faculty of the institution suggested that the sample items were best for pH testing. Refer to Appendix J for the complete pH paper representation of values. Table 6 summarizes the results of the accuracy testing of the pH Meter feeding system.

Test Number	items	Reading of pH meter	Color of litmus paper	Reading of pH paper	pH level
1	Liquid Sosa	13.5	Red turns Blue	14	Basic
2	Pure Water	6.9	Purple	7	Neutral
3	Vinegar	3.4	Blue turns Red	3	Acidic

Table 6: Accuracy Test Results of pH Meter

Table 7 summarizes the results of the reliability testing of the pH meter. The researchers compared the reading of the pH meter to the color of the litmus paper depending on the pH level of the sample items if it was acidic, neutral or basic. Also, if the reading of the pH meter did not fluctuate or vary, success was indicated. Otherwise, failure would be indicated in the test. Refer to Appendix J for the complete pH paper representation of values.

Test Number	items	Reading of pH meter	Color of litmus paper	Reading of pH paper	pH level	Test Results
1	Liquid Sosa	13.5	Red turns Blue	14	Basic	Successful
2	Pure Water	6.9	Purple	7	Neutral	Successful
3	Vinegar	3.4	Blue turns Red	3	Acidic	Successful

Table 7: Reliability Test Results of pH Meter

The accuracy of the water replacement system was tested by the actual use of pump motor and two float switches placed inside the aquarium. It was activated when the pH meter exceeded or went below normal the pH value, which were 6.6 to 7.3 according to Professor Ariziel Ruth D. Marquez. Furthermore, Mr. Amador Domingo Jr., told the researchers that the average water to be replaced was ¼ of the total volume. The pump motor would drain ¼ of the water inside the aquarium and to make sure that it would only drain ¼ of the water; the researchers used two float switches that acted as a level sensor. The first sensor was at the top, while the second one was below the middle part of the aquarium. The second level sensor should be reached by the level of the water for the pump motor to stop. After ¼ of water was drained, the solenoid valve would be triggered and would also allow the water to flow from the water source to the aquarium. The first level sensor should be reached by the level of the water for the solenoid valve to stop allowing the flow of water. Two actual

testing was conducted to perform the accuracy and reliability testing of the water replacement system. Table 8 summarizes the results of Water Replacement System. SW1 represents the float switch 1, SW2 for float switch 2, M4 for the pump motor and M2 for the solenoid valve.

Test Number	Starting Water Level	Water Reaches SW2	Water Reaches SW1	M4 Activates	M2 activates
1	High	Yes	No	No	Yes
2	Low	No	Yes	Yes	No

Table 8: Accuracy Test Results of Water Replacement System

Table 9 summarizes the results of the reliability testing of the water replacement system. To check if the pump motor would drain water. The water level was high until it reached the second level sensor and if the solenoid valve allowed flowing of water. The water level was low if it reached the first level sensor. Also, if the pump motor and solenoid valve were not activated at the same time, success was indicated. Otherwise, failure was indicated in the test. The syringe approximately poured 5 drops of dechlorination liquid, which was enough for 1 gallon of water. The system could be tested if dechlorination liquid would be dispensed from the syringe after the water replacement process. The amount of dechlorination liquid to be poured was 5 drops for every gallon of water replaced as stated on page 10. In this case, the water replacement system replaced about 2 gallons of water. Thus, 10 drops o dechlorinated liquid was released from the syringe.

Test Number	Starting Water Level	Water Reaches SW2	Water Reaches SW1	M4 Activates	M2 Activates	Results
1	High	Yes	No	No	Yes	Successful
2	Low	No	Yes	Yes	No	Successful

Table 9: Reliability Test Results of Water Replacement System

The Dechlorination system was done by pouring dechlorination liquid from the syringe so that the new water would be neutralized. Two actual testing was conducted to perform the accuracy and reliability testing of the dechlorination system. Table 10 summarizes the results of the Accuracy Test Results of Dechlorination System of Water Replacement System. M2 represents the solenoid valve and for the SW1 represents the float switch 1.

Test Number	Water Reaches SW1	M2 Deactivates	Syringe Activates
1	Yes	Yes	Yes
2	No	No	No

Table 10: Accuracy Test Results of Dechlorination System

Table 11 summarizes the results of the reliability testing of the dechlorination system. If the dechlorination liquid will be poured after the water replacement process and vice versa, success will be indicated. Otherwise, failure is indicated in the test.

Test Number	Water reaches SW1	M2 deactivates	Syringe Activates	Volume of dispensed dechlorination liquid	Results
1	Yes	Yes	Yes	1 ml	Successful
2	No	No	No	0 ml	Successful

Table 11: Reliability Test Results of Dechlorination System

The researchers did not fully depend on the pH meter checking whether the water was still clean or not. They set a condition on the system that if the day counter is equal to 14, the system will activate the water replacement. Table 12 summarizes the results of the Accuracy Test Results of Day Counter Policy.

Test Number	Day Count	Activate Water replacement
1	1	No
2	2	No
3	3	No
4	4	No
5	5	No
6	6	No
7	7	No
8	8	No
9	9	No
10	10	No
11	11	No
12	12	No
13	13	No
14	14	Yes

Table 12: Accuracy Test Results of Day Counter Policy

Table 13 summarizes the results of the reliability testing of the pH meter reading if it was still neutral and if the day counter had a value of 14 after the last water replacement process took place. Also, if the day counter resets back to zero after the water replacement process took place. Otherwise, failure was indicated in the test. M4 represents Water Pump and M2 is for the Solenoid Valve.

Test Number	Day count	M2 activate after M4	Syringe Activates	Results
1	**1**	**No**	**No**	**Successful**
2	**2**	**No**	**No**	**Successful**
3	**3**	**No**	**No**	**Successful**
4	**4**	**No**	**No**	**Successful**
5	**5**	**No**	**No**	**Successful**
6	**6**	**No**	**No**	**Successful**
7	**7**	**No**	**No**	**Successful**
8	**8**	**No**	**No**	**Successful**
9	**9**	**No**	**No**	**Successful**
10	**10**	**No**	**No**	**Successful**
11	**11**	**No**	**No**	**Successful**
12	**12**	**No**	**No**	**Successful**
13	**13**	**No**	**No**	**Successful**
14	**14**	**Yes**	**Yes**	**Successful**

Table 13: Reliability Test Results of day counter policy

Chapter 4

CONCLUSION AND RECOMMENDATION

CONCLUSION

The researchers developed an effective microcontroller based on self – maintained aquarium using PIC16F877 with sensors – a device that can monitor the status and switch motors "on" or "off" remotely through microcontroller. The group was able to interface the microcontroller to the pH meter unit, filter unit, automatic feeder unit, and lighting system unit, to the relays and to the manual switches. The circuit was designed and the correct program was likewise created to perform the desired functions based on the group's intentions.

With the general objective of the study to develop a microcontroller based on self – maintained aquarium, the researchers came with the conclusion based upon the specific objectives:

1. A Filtration system ensures the disposal of solid wastes from the aquarium depending on the set of time which will be activated by a filter device. It filters on a duration of 2 hours for every filter cycle which is enough to keep the aquarium clean and also keeping the vibration from the filter motor reduced to a minimum that caused the fishes to be stressed.

2. An automatic feeder releases an amount of pellets that is enough for the specific number of fish inside the aquarium. The feeder is a customized feeder box.

3. A pH sensor detects the pH level of the water if it is already acidic or basic. It is used to monitor the water if it is clean or dirty. It will also stop monitoring the pH level after the 1 hour interval of the water replacement process which took place to avoid fish stress.

4. Water replacement system drains and replaces water if it is already acidic or basic (monitored by the pH meter) so that the fishes will have a clean water environment inside the aquarium. This system will also be activated after 14 days of constant neutral reading of the pH meter.

5. Dechlorination system dispenses dechlorination liquid from a syringe to neutralize the chlorine of the water. It will be activated right after the water replacement process is finished.

6. Lightning system uses LDR to detect if there is light on the surrounding before the fluorescent lamp will turn ON or OFF.

Through this system the user will not encounter problems in taking care of their pet fishes if they are not in the house or at the premises where the aquarium is located and at the same time ensures the safety of the fishes from dying due to lack of food pellets and too much chlorine that are bad for the fish. It will also limit diseases for the fish because the system enables the water replacement that cleans the aquarium, a user-friendly device, and definitely requires less maintenance.

RECOMMENDATION

Several improvements can be added to the device to further enhance its capabilities:

1. The addition of a wiper to the screen or glass of the aquarium so that the dirt on the glass will be wiped out.
2. A sensor that will trigger the alarm when the storage containers of the feeder and dechlorination is empty.
3. The security PIN can also be implemented to avoid the child/children from changing the user's preferences and for its

security purposes, a system that will enable the user to view the activities happening in the aquarium and can be accessed online.

4. A system that will verify all the hardware components attached to the machines are working properly.

5. Temperature sensor can also be added so that the user will be informed about the temperature reading of his aquarium. Temperature is also a major factor that should be considered for the health of the fishes.

6. Different kinds of fishes that can be handled and properly taken care of in the aquarium.

7. A slight change on the program is also possible so that the users can input what time he/she wants to filter his/her aquarium and the time to feed the fishes.

8. The value of the pH level is not displayed and replaced by a note on the LCD that the pH meter is disabled because it already detected that the water is acidic or basic.

9. A feeding system that will accurately dispense the volume of pellets according to the volume setting defined by the user.

10. A sensor measuring the level of dissolved oxygen in the water may also be useful to ensure the quality of living conditions of the fishes

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APPENDICES

APPENDIX A

PIC16F877 DATASHEET

MICROCHIP

PIC16F87X

28/40-Pin 8-Bit CMOS FLASH Microcontrollers

Devices Included in this Data Sheet:

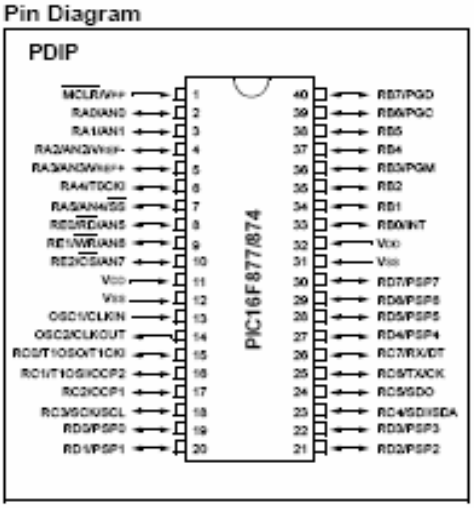
- PIC16F873
- PIC16F874
- PIC16F876
- PIC16F877

Microcontroller Core Features:

- High performance RISC CPU
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 20 MHz clock input
  DC - 200 ns instruction cycle
- Up to 8K x 14 words of FLASH Program Memory,
  Up to 368 x 8 bytes of Data Memory (RAM)
  Up to 256 x 8 bytes of EEPROM Data Memory
- Pinout compatible to the PIC16C73B/74B/76/77
- Interrupt capability (up to 14 sources)
- Eight level deep hardware stack
- Direct, Indirect and relative addressing modes
- Power-on Reset (POR)
- Power-up Timer (PWRT) and Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving SLEEP mode
- Selectable oscillator options
- Low power, high speed CMOS FLASH/EEPROM technology
- Fully static design
- In-Circuit Serial Programming™ (ICSP) via two pins
- Single 5V In-Circuit Serial Programming capability
- In-Circuit Debugging via two pins
- Processor read/write access to program memory
- Wide operating voltage range: 2.0V to 5.5V
- High Sink/Source Current: 25 mA
- Commercial, Industrial and Extended temperature ranges
- Low-power consumption:
  - < 0.6 mA typical @ 3V, 4 MHz
  - 20 µA typical @ 3V, 32 kHz
  - < 1 µA typical standby current

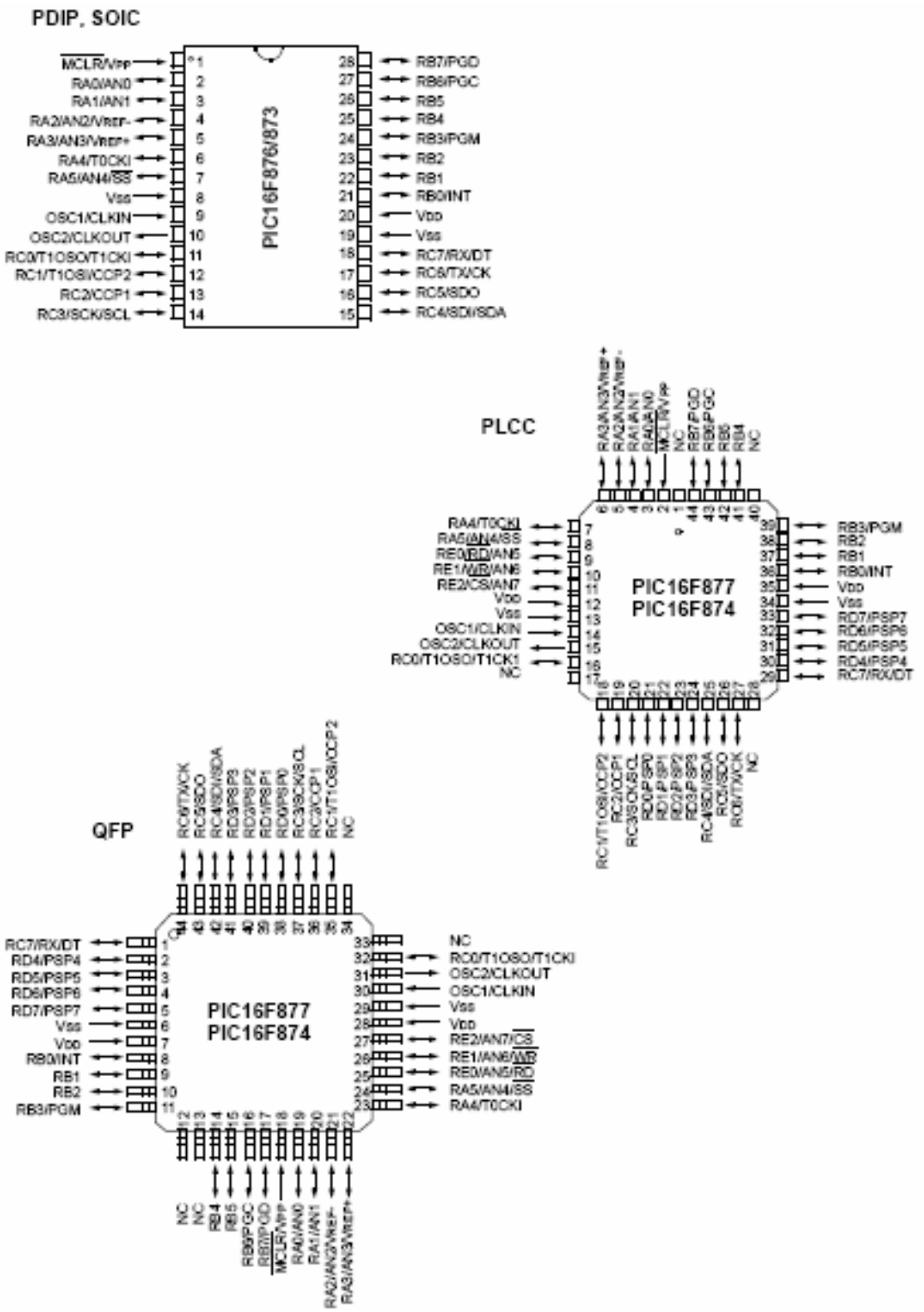
Pin Diagram

PDIP



Peripheral Features:

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during SLEEP via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- 10-bit multi-channel Analog-to-Digital converter
- Synchronous Serial Port (SSP) with SPI™ (Master mode) and I²C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) 8-bits wide, with external RD, WR and CS controls (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)


PDIP, SOIC
PIC16F876/873
MCLR/VPP
RA0/AN0
RA1/AN1
RA2/AN2/VREF-
RA3/AN3/VREF+
RA4/T0CKI
RA5/AN4/SS
VSS
OSC1/CLKIN
OSC2/CLKOUT
RC0/T1OSO/T1CKI
RC1/T1OSI/CCP2
RC2/CCP1
RC3/SCK/SCL
RB7/PGD
RB6/PGC
RB5
RB4
RB3/PGM
RB2
RB1
RB0/INT
VDD
VSS
RC7/RX/DT
RC6/TX/CK
RC5/SDO
RC4/SDI/SDA
PLCC
PIC16F877
PIC16F874
QFP
PIC16F877
PIC16F874

Key Features PICmicro™ Mid-Range Reference Manual (DS33023)	PIC16F873	PIC16F874	PIC16F876	PIC16F877
Operating Frequency	DC - 20 MHz	DC - 20 MHz	DC - 20 MHz	DC - 20 MHz
RESETS (and Delays)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)
FLASH Program Memory (14-bit words)	4K	4K	8K	8K
Data Memory (bytes)	192	192	368	368
EEPROM Data Memory	128	128	256	256
Interrupts	13	14	13	14
I/O Ports	Ports A,B,C	Ports A,B,C,D,E	Ports A,B,C	Ports A,B,C,D,E
Timers	3	3	3	3
Capture/Compare/PWM Modules	2	2	2	2
Serial Communications	MSSP, USART	MSSP, USART	MSSP, USART	MSSP, USART
Parallel Communications	—	PSP	—	PSP
10-bit Analog-to-Digital Module	5 Input channels	8 Input channels	5 Input channels	8 Input channels
Instruction Set	35 Instructions	35 Instructions	35 Instructions	35 Instructions

APPENDIX B

BA6219B DATASHEET

Reversible motor driver

BA6219B / BA6219BFP-Y

The BA6219B and BA6219BFP-Y are reversible-motor drivers suitable for brush motors. Two logic inputs allow four output modes: forward, reverse, idling, and braking. The motor revolving speed can be set arbitrarily by controlling the voltage applied to the motor.

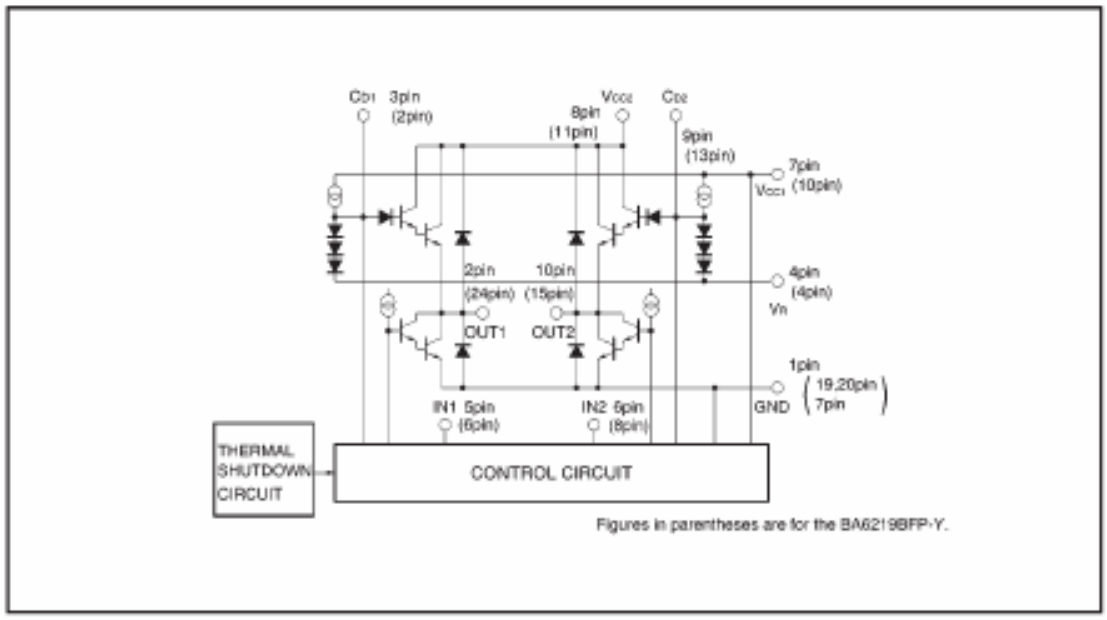
●Applications

VCRs and cassette tape recorders

●Features

1) Large output current. (I_O=2.2A Max.)
2) Built-in thermal shutdown circuit.
3) Built-in output voltage setting pins.
4) Small standby supply current.

●Block diagram



Figures in parentheses are for the BA6219BFP-Y.

●Absolute maximum ratings (Ta = 25° C)

Parameter		Symbol	Limits	Unit
Power supply voltage		V_{CC1}, V_{CC2}	24	V
Power dissipation	BA6219B	Pd	2200*1	mW
	BA6219BFP - Y		1450*2	
Operating temperature		Topr	−20~+75	℃
Storage temperature		Tstg	−50~+125	℃
Output current		I_O	2.2*3	A
Input voltage		V_{IN}	−0.3~V_{CC1}	V

*1 Reduced by 22 mW for each increase in Ta of 1℃ over 25℃.

*2 When mounted on a 90 X 50 X 1.6 mm glass epoxy board.
Reduced by 14.5 mW for each increase in Ta of 1℃ over 25℃.

*3 500 μs pulse with a duty ratio of 1%.

●Recommended operating conditions (Ta = 25° C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Operating power supply voltage	V_{CC1}	8	—	18	V
	V_{CC2}				

●Electrical characteristics (unless otherwise noted, Ta = 25° C and V_{CC} = 12V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Current dissipation 1	I_{CC1}	—	1.2	2.5	mA	Both input pins LOW
Current dissipation 2	I_{CC2}	—	16	35	mA	One input pin HIGH, the other LOW
Current dissipation 3	I_{CC3}	—	25	60	mA	Both input pins HIGH
Input threshold voltage	V_{TH}	1.0	2.0	3.0	V	Low level is 1 V or less, HIGH level is 3 V or more
Output high level voltage	V_H	6.5	—	—	V	R_L=60Ω, ZD=6.8V
Output low level voltage	V_L	—	—	1.2	V	R_L=60Ω

●Electrical characteristic curves

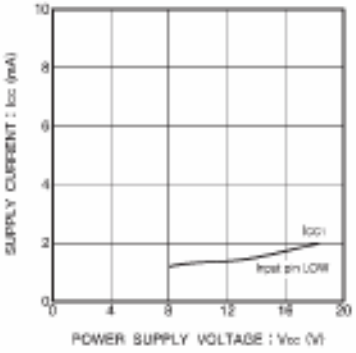


Fig.1 Current dissipation 1 vs. power supply voltage

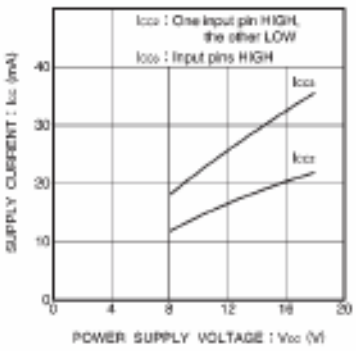


Fig.2 Current dissipation 2,3 vs. power supply voltage

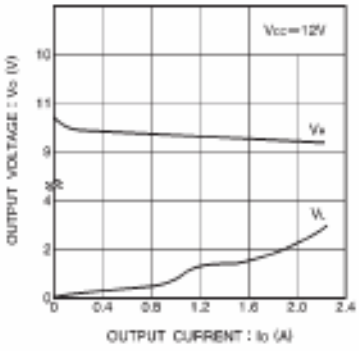


Fig.3 Output voltage vs. output current

●Application examples

(1) BA6219B

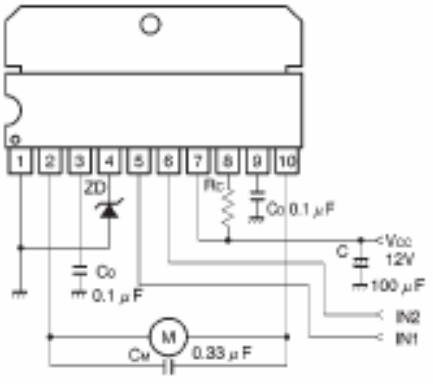


Fig.11

ZD : Zener diode to set output voltage. Use any zener diode that is suitable for your application.

R_C : Resistor used for reducing collector loss and limiting the short-circuit current. A resistance range of 3 -- 10Ω is recommended.

C : Power supply filtering capacitor. Place as near as possible to the V_{CC1} pin.

CD : Capacitor to prevent both output transistors being turned on at the same time.

CM : Capacitor to absorb surge voltage and prevent parasitic oscillations.

(2) BA6219BFP-Y

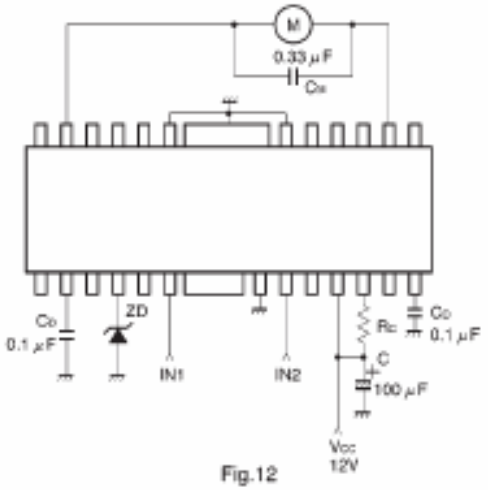
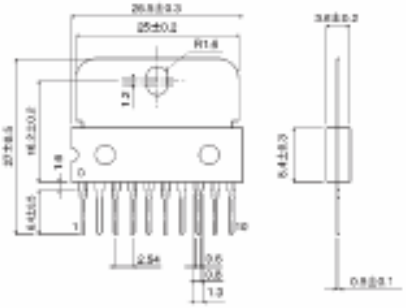


Fig.12

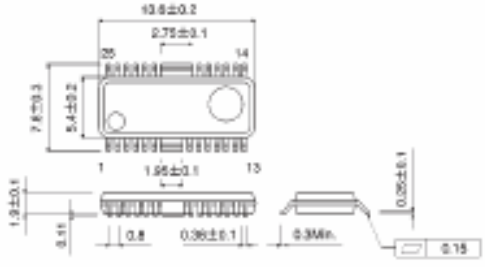
●External dimensions (Units: mm)

BA6219B



HSIP10

BA6219BFP-Y



HSOP25

APPENDIX C

HD44780 LCD DATASHEET

HD44780U (LCD-II)

(Dot Matrix Liquid Crystal Display Controller/Driver)

HITACHI

ADE-207-272(Z)
'99.9
Rev. 0.0

Description

The HD44780U dot-matrix liquid crystal display controller and driver LSI displays alphanumerics, Japanese kana characters, and symbols. It can be configured to drive a dot-matrix liquid crystal display under the control of a 4- or 8-bit microprocessor. Since all the functions such as display RAM, character generator, and liquid crystal driver, required for driving a dot-matrix liquid crystal display are internally provided on one chip, a minimal system can be interfaced with this controller/driver.

A single HD44780U can display up to one 8-character line or two 8-character lines.

The HD44780U has pin function compatibility with the HD44780S which allows the user to easily replace an LCD-II with an HD44780U. The HD44780U character generator ROM is extended to generate 208 5 × 8 dot character fonts and 32 5 × 10 dot character fonts for a total of 240 different character fonts.

The low power supply (2.7V to 5.5V) of the HD44780U is suitable for any portable battery-driven product requiring low power dissipation.

Features

- 5 × 8 and 5 × 10 dot matrix possible
- Low power operation support:
  — 2.7 to 5.5V
- Wide range of liquid crystal display driver power
  — 3.0 to 11V
- Liquid crystal drive waveform
  — A (One line frequency AC waveform)
- Correspond to high speed MPU bus interface
  — 2 MHz (when V_{CC} = 5V)
- 4-bit or 8-bit MPU interface enabled
- 80 × 8-bit display RAM (80 characters max.)
- 9,920-bit character generator ROM for a total of 240 character fonts
  — 208 character fonts (5 × 8 dot)
  — 32 character fonts (5 × 10 dot)

HD44780U

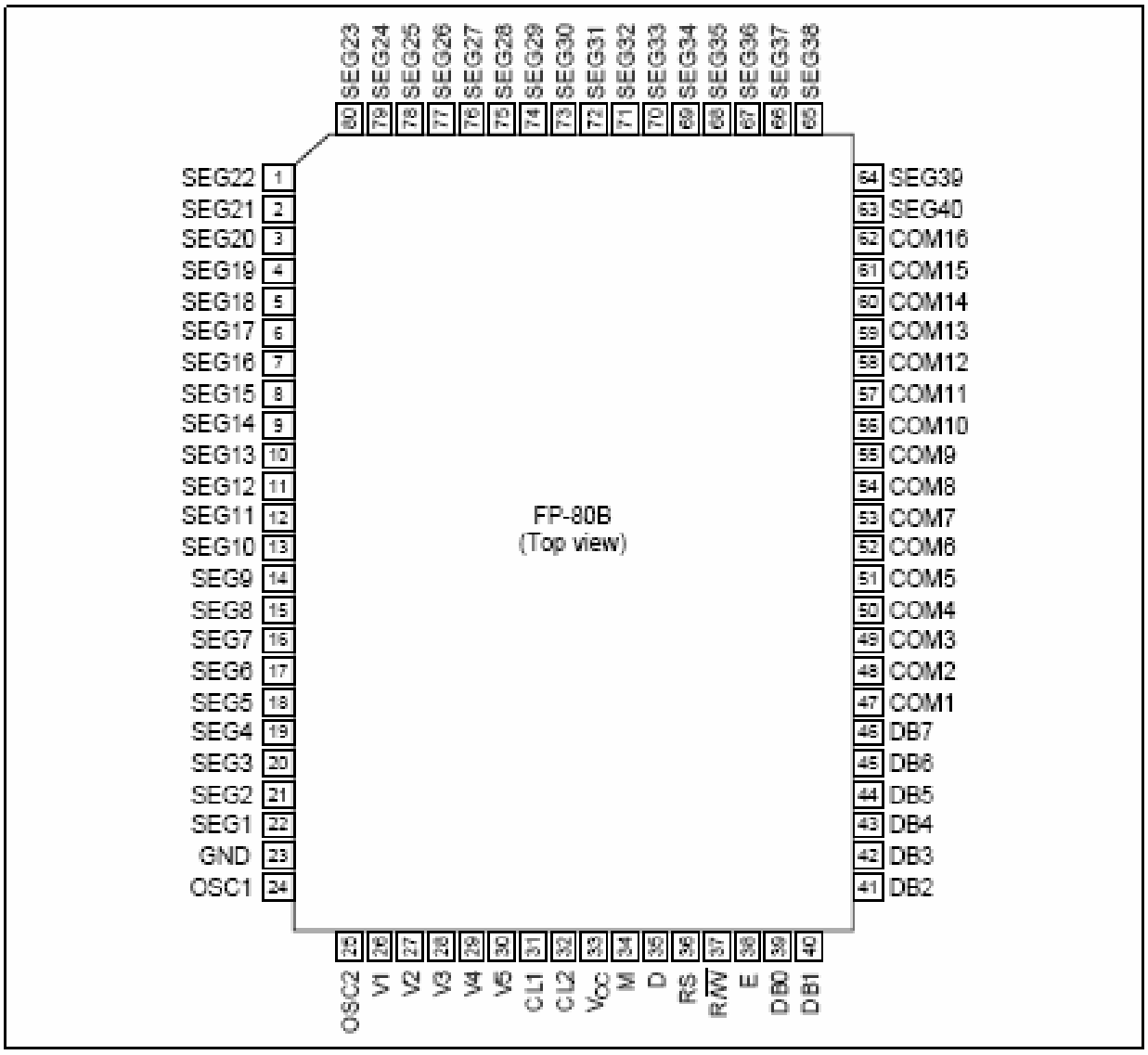
- 64 × 8-bit character generator RAM
  - — 8 character fonts (5 × 8 dot)
  - — 4 character fonts (5 × 10 dot)
- 16-common × 40-segment liquid crystal display driver
- Programmable duty cycles
  - — 1/8 for one line of 5 × 8 dots with cursor
  - — 1/11 for one line of 5 × 10 dots with cursor
  - — 1/16 for two lines of 5 × 8 dots with cursor
- Wide range of instruction functions:
  - — Display clear, cursor home, display on/off, cursor on/off, display character blink, cursor shift, display shift
- Pin function compatibility with HD44780S
- Automatic reset circuit that initializes the controller/driver after power on
- Internal oscillator with external resistors
- Low power consumption

Ordering Information

Type No.	Package	CGROM
HD44780UA00FS	FP-80B	Japanese standard font
HCD44780UA00	Chip	
HD44780UA00TF	TFP-80F	
HD44780UA02FS	FP-80B	European standard font
HCD44780UA02	Chip	
HD44780UA02TF	TFP-80F	
HD44780UBxxFS	FP-80B	Custom font
HCD44780UBxx	Chip	
HD44780UBxxTF	TFP-80F	

Note: xx: ROM code No.

HD44780U Pin Arrangement (FP-80B)



APPENDIX D
7805 VOLTAGE REGULATOR DATASHEET

FAIRCHILD SEMICONDUCTOR®

www.fairchildsemi.com

KA78XX/KA78XXA

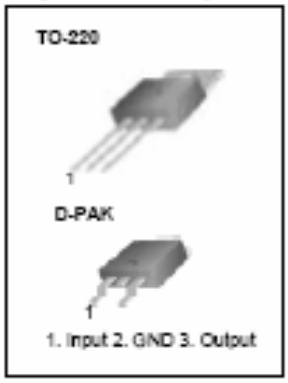
3-Terminal 1A Positive Voltage Regulator

Features

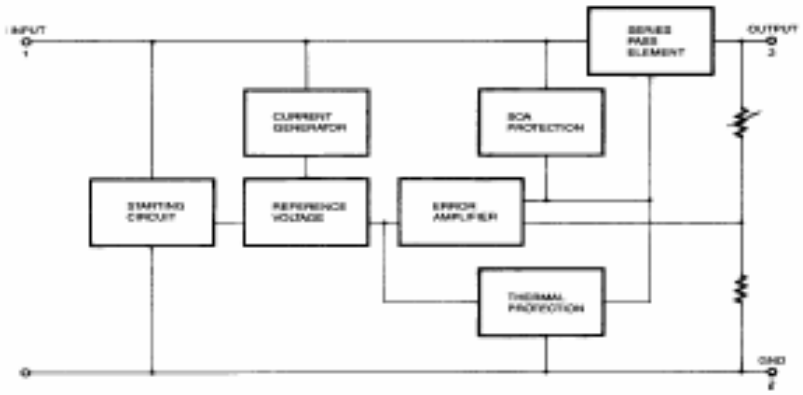
- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

Description

The KA78XX/KA78XXA series of three-terminal positive regulator are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.



Internal Block Digram



Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Input Voltage (for V_O = 5V to 18V) (for V_O = 24V)	V_I V_I	35 40	V V
Thermal Resistance Junction-Cases (TO-220)	RθJC	5	°C/W
Thermal Resistance Junction-Air (TO-220)	RθJA	65	°C/W
Operating Temperature Range (KA78XX/A/R)	T_{OPR}	0 ~ +125	°C
Storage Temperature Range	T_{STG}	-65 ~ +150	°C

Electrical Characteristics (KA7805/KA7805R)

(Refer to test circuit ,0°C < T_J < 125°C, I_O = 500mA, V_I =10V, C_I= 0.33μF, C_O=0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		KA7805			Unit
				Min.	Typ.	Max.	
Output Voltage	V_O	T_J =+25 °C		4.8	5.0	5.2	V
		5.0mA ≤ Io ≤ 1.0A, PO ≤ 15W V_I = 7V to 20V		4.75	5.0	5.25	
Line Regulation (Note1)	Regline	T_J=+25 °C	V_O = 7V to 25V	-	4.0	100	mV
			V_I = 8V to 12V	-	1.6	50	
Load Regulation (Note1)	Regload	TJ=+25 °C	IO = 5.0mA to1.5A	-	9	100	mV
			IO =250mA to 750mA	-	4	50	
Quiescent Current	I_Q	T_J =+25 °C		-	5.0	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1.0A		-	0.03	0.5	mA
		V_I= 7V to 25V		-	0.3	1.3	
Output Voltage Drift	ΔVO/ΔT	IO= 5mA		-	-0.8	-	mV/°C
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A=+25 °C		-	42	-	μV/V_O
Ripple Rejection	RR	f = 120Hz V_O = 8V to 18V		62	73	-	dB
Dropout Voltage	VDrop	IO = 1A, TJ =+25 °C		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	15	-	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A =+25 °C		-	230	-	mA
Peak Current	IPK	T_J =+25 °C		-	2.2	-	A

APPENDIX E
4MHz CRYSTAL OSCILLATOR DATASHEET

HIGH FREQUENCY CYLINDRICAL TYPE MICROPROCESSOR CRYSTAL

AB308

RoHS Compliant

FEATURES:

- High stability by tight vacuum sealing
- Excellent resistant to vibration and shock
- Miniature high frequency cylinder type crystal

APPLICATIONS:

- Suitable for wide range of application
- Clocks for microprocessor
- Consumer electronics
- Test equipment
- Computer peripherals

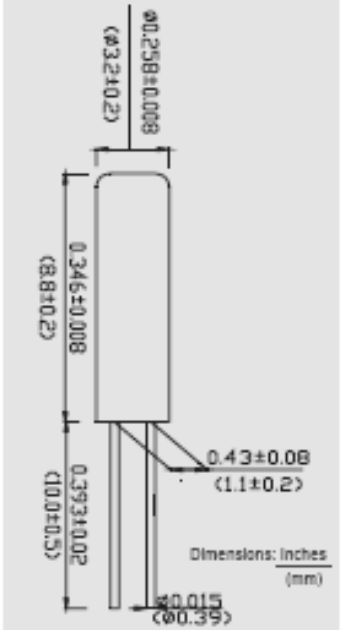
STANDARD SPECIFICATIONS:

PARAMETERS	
ABRACON P/N	AB308 Series
Frequency	4.001 MHz to 90 MHz
Operation Mode	4.001 MHz - 32.0 MHz (Fundamental) 30.01 - 90.00 MHz (3rd - Overtone)
Operating Temperature	-10°C to + 60°C (see options)
Storage Temperature	- 40°C to + 85°C
Frequency Tolerance	± 30 ppm max. (see options)
Frequency Stability over the Operating Temp. (Ref to +25°C)	± 50 ppm max. (see options)
Equivalent Series Resistance (R1)	See Table 1
Shunt Capacitance C_0	5pF max.
Load Capacitance C_L	16pF (see options)
Drive Level	100µW max.
Aging at 25°C Per Year	± 5ppm max.
Insulation Resistance	500 MΩ min at 100Vdc ± 15V

TABLE 1: ESR

FREQUENCY (MHz)	ESR (Ω)
4.001-5.999	150
6.000-9.999	100
10.000-32.000	50
30.000-35.99(OT)	100
36.00-90.00(OT)	80

OUTLINE DRAWING:



OPTIONS AND PART IDENTIFICATION:

[Left blank if standard]

AB308 - Frequency - □ - R□□□ - □ - □ - □ - □

Frequency
XX.XXXX MHz

Load Capacitance
Please specify CL in pF or S for Series (minimum 10pF)

ESR
RXXX (Value in Ω)

Operating Temp.	
E	-0°C to +70°C
B	-20°C to +70°C
D	-40°C to +85°C

Freq. Tolerance	
S	± 50 ppm

Mode	
F	Fund. AT>10MHz
FB	Fund BT>30MHz

Freq. Stability	
Y	± 30 ppm

ABRACON IS ISO 9001 / QS 9000 CERTIFIED

ABRACON CORPORATION

Visit www.abracon.com for Terms & Conditions of Sale Revised: 02.15.08

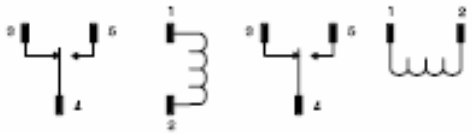
30332 Esperanza, Rancho Santa Margarita, California 92688
tel 949-546-8000 | fax 949-546-8001 | www.abracon.com

APPENDIX F
SPDT RELAY SWITCH DATASHEET

Features

- Epoxy Sealed for Wave Soldering & Cleaning
- Upright (V Suffix) or Flat–Pack (FP Suffix) Types
- High Dielectric – 4000 VRMS between Control and Switching Circuits
- Cut–Off Nib after PCB Washing
- 94 V–0 Enclosure

SPDT, 1 Form "C"



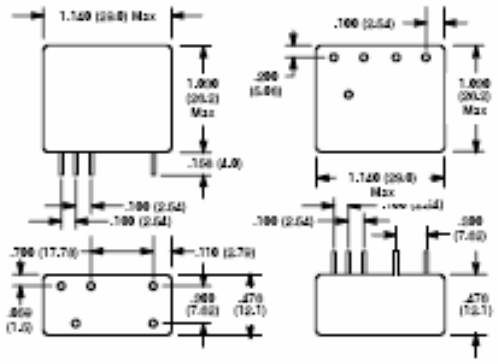
Upright Flat–Pack

DC OPERATED						
NTE Type No.	Nom. Voltage	Contact Arr.	Coil Res. Ohms (Typ)	Nom. Power	Max. Contact Cur. @ 28VDC or 120VAC	Diag No.
R24–6D10–6V	6VDC	SPDT	50	600mW	10A	D10a
R24–6D10–6FP	6VDC	SPDT	50	600mW	8A	D10b
R24–6D10–12V	12VDC	SPDT	215	600mW	10A	D10a
R24–6D10–12FP	12VDC	SPDT	200	600mW	8A	D10b
R24–6D10–24V	24VDC	SPDT	740	600mW	10A	D10a
R24–6D10–24FP	24VDC	SPDT	1200	600mW	8A	D10b

R24 Series

8 Amp & 10 Amp, SPDT Epoxy Sealed Power Relay.

D15a D15b



Cut–off nib after PCB washing to extend contact life and lower operating temperature.

Electrical Specifications

Contact

Rating Resistive Load:
10 Amp @ 380 VAC max switching (Upright)
8 Amp @ 250 VAC max switching (Flat–Pack)
Contact Material: Silver Cadmium Oxide (Upright)
Silver, Gold Flashed (Flat–Pack)
Contact Resistance: .08 Ohms Max. initial (Upright)
.05 Ohms Max. initial (Flat–Pack)

Coil

Coil Voltages: See Chart
Pick–up Voltage: 80% of nom voltage or less @ 25°C
Drop–out Voltage: 10% of actual pull–in (min)
Resistance: See chart
Min Sensitivity: 400 mW
Nominal Power: 600 mW

Operational Characteristics

Timing Values ..... **Operate Time:** Approx 6 mS (Upright)
Approx 15 mS (Flat–Pack)
Release Time: Approx 2 mS (Upright)
Approx 10 mS (Flat–Pack)
Max Switching Rate: 5 operations per second

Insulation Characteristics

Dielectric Strength
Contact To Coil: 4000 VRMS
Across Open Contacts: 1000 VRMS

Resistance:

Contact to Coil/Frame: 1000 megohms min.
Across Open Contacts: 500 Megohms min.
Coil To Frame: 1000 megohms Min.

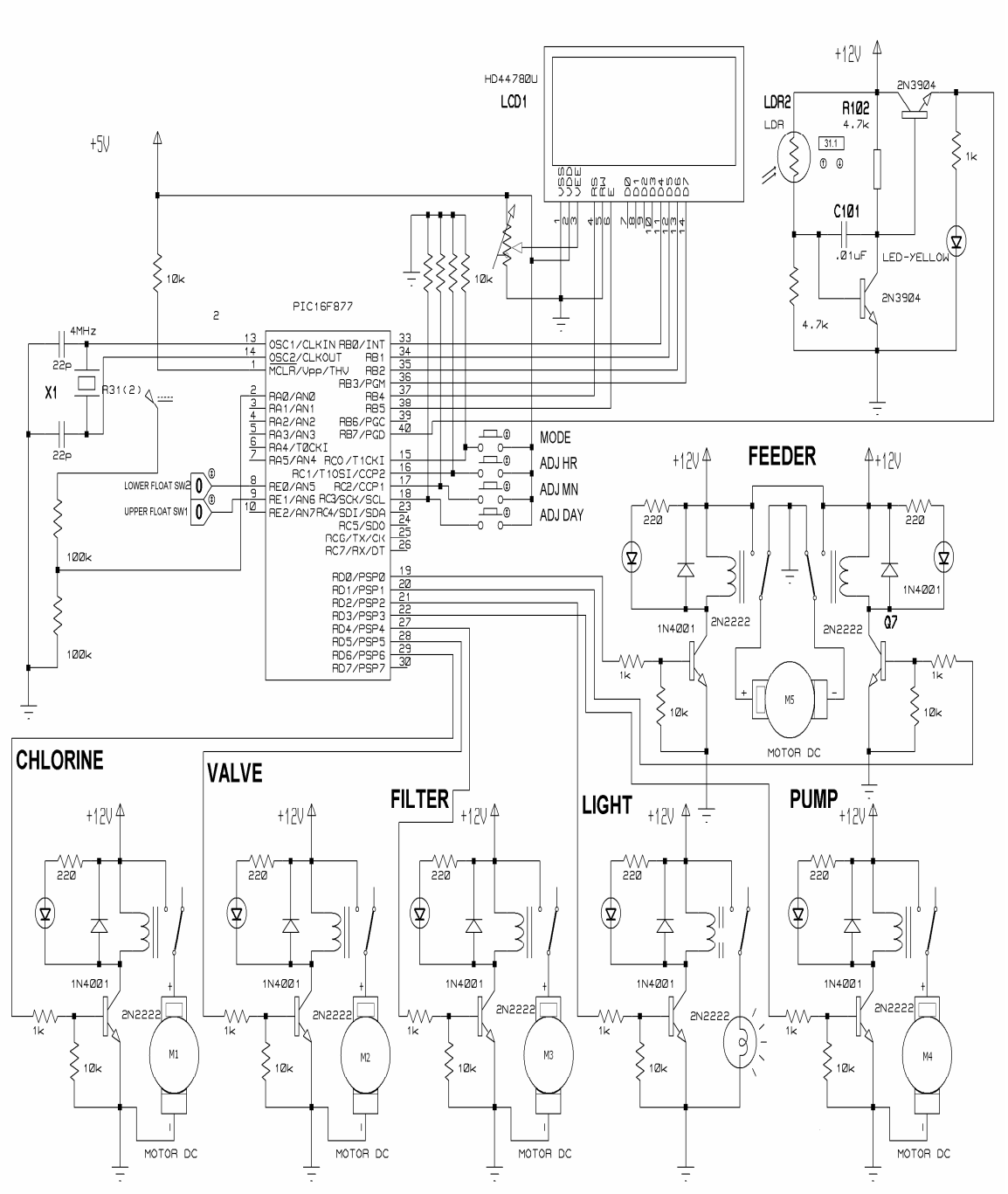
Environmental Characteristics

Operating: –55°C to +70°C
Mechanical Life: 5×10^6 operations min

Weight

Std: 15 gram approx.

APPENDIX G
SCHEMATIC DIAGRAM



APPENDIX H
SOURCE CODE

```
'*****************************************************************
'*  Name    : AQUARIUM.BAS                                       *
'*  Author  : SHREK                                              *
'*  Notice  : Copyright (c) 2008 [select VIEW...EDITOR OPTIONS] *
'*          : All Rights Reserved                                *
'*  Date    : 6/30/2008                                          *
'*  Version : 1.0                                                *
'*  Notes   :                                                    *
'*          :                                                    *
'*****************************************************************

Device 16F877
Declare XTAL = 4
Declare LCD_TYPE 0
Declare LCD_DTPIN PORTB.0
Declare LCD_ENPIN PORTB.5
Declare LCD_RSPIN PORTB.4
Declare LCD_INTERFACE 4
Declare LCD_LINES 4

Symbol Button1   PORTC.0
Symbol Button2   PORTC.1
Symbol Button3   PORTC.2
Symbol Button4   PORTC.3


TRISA=%000001
TRISB=%10000000
TRISC=%00001111
TRISD=%00000000
TRISE=%011
ADCON1 = 4

Dim on_screen As Bit
Dim hour      As Byte
Dim minute    As Byte
Dim second    As Byte
Dim settings  As Byte
Dim up_minute As Byte
Dim up_hour   As Byte
```

```
Dim x         As Byte
Dim onetime   As Byte
Dim DAY_CTR   As Byte
Dim H2O_rep   As Byte
Dim HF1       As Bit
Dim HF2       As Bit
Dim pH_METER  As Float
Dim Lamp      As Bit

Dim   FOOD_CTR    As Byte
Dim   FISH        As Byte
Dim   TIME_FISH   As Byte
Dim   VALVE_FLG   As Byte
Dim   PUMP_FLG    As Byte
Dim   pH_METER_FLG As Byte
Dim   FEEDER_FLG  As Byte
Dim   BYPASS      As Byte
Dim   pHM_CTR     As Byte
Dim   TEST        As Byte
Dim   PUMP_CHK    As Byte
Dim   VALVE_CHK   As Byte

Dim   Vlve        As Bit
Dim   fltr        As Bit
Dim   pmp         As Bit



Symbol   FSW1      PORTE.0
Symbol   FSW2      PORTE.1

Symbol Feeder_On    PORTD.0
Symbol feeder_Off   PORTD.1
Symbol   FILTER    PORTD.2
Symbol   PUMP      PORTD.3
Symbol   LIGHT     PORTD.4
Symbol   VALVE     PORTD.5
Symbol   CHLORINE  PORTD.6
```

```
    settings    = 1
    on_screen   = 1
    x           = 0
    onetime     = 0
    HF1         = 0
    HF2         = 0
    VALVE_FLG   = 0
    PUMP_FLG    = 0
    pH_METER_FLG = 1
    FEEDER_FLG  = 1
    pHM_CTR     = 0
    PUMP_CHK    = 0
    VALVE_CHK   = 0
    FISH        = 0
    Lamp        = 0
    Vlve        = 0
    fltr        = 0
    pmp         = 0

    DelayMS 150
    hour     = 0
    minute   = 0
    second   = 0

    DelayMS 100

    FISH    = ERead 0
    DAY_CTR = ERead 1
    FOOD_CTR = FISH

'----  Initialization ----   "
PORTA = 0
PORTB = 0
PORTC = 0
PORTD = 0
PORTE = 0

;----------  CUSTOM CHAR LCD   -------------

Print $FE,$40,$08,$04,$16,$1D,$16,$04,$08,$00
Print $FE,$48,$0E,$1F,$1F,$1F,$0E,$0A,$0E,$00
Print $FE,$50,$0E,$11,$11,$11,$0E,$0A,$0E,$00
Print $FE,$58,$02,$04,$0D,$17,$0D,$04,$02,$00
Print $FE,$60,$0E,$04,$0F,$18,$00,$08,$14,$00
```

```
Print $FE,$68,$15,$0E,$1B,$0A,$0E,$15,$00,$00
'-----------------------------------------------------------------------------------------------
-
simula:
          Cls
        Print At 1, 1,  "     M A P U A      "
       Print At 2, 1,  "School of EE-ECE-CoE"
       Print At 3, 1,  "   SELF-MAINTAIN    "
       Print At 4, 1,  "     AQUARIUM       "
       DelayMS 1500
       Cls
      GoTo   MAIN
'-----------------------------------------------------------------------------------------------
-

getad:
       DelayMS 50
       ADCON0.2 = 1
       DelayMS 50
       Return

getx:
       ADCON0 = $41
       GoSub getad
       pH_METER = ADRESH / 28
       Return
'-----------------------------------------
MAIN:


  If on_screen = 1 Then GoSub TO_SCREEN
  If on_screen = 1 Then GoSub GET_TIME
  If Button1 = 1  Then
    settings = settings + 1
    Print $fe, 1
    on_screen = 0
    GoTo MENU_SET
  EndIf
  If settings = 2 And Button2 = 1 Then GoTo MENU_UUR
  If settings = 2 And Button3 = 1 Then GoTo MENU_MINUUT
  If settings = 3 And Button4 = 1 Then GoTo fish_counter
  If settings = 4 And Button4 = 1 Then GoTo MENU_DAY_COUNTER
```

```
'=============================================================
=
'=============================================================
=
' ------------------------------   Activate FEEDER   ----------------------------------
-----
   If hour = 9 And minute = 0 And FEEDER_FLG = 1 Then          '9:00
      GoSub onfeeder
   Else
      If hour = 21 And minute = 0 And FEEDER_FLG = 1 Then      '21:00
         GoSub onfeeder
      EndIf
   EndIf
' ------------------------------   Activate Light   ----------------------------------
-
   If PORTB.7 = 1 Then
      Lamp = 1
      High LIGHT
   Else
      Lamp = 0
      Low LIGHT
   EndIf
' ---------------------------   Activate/Deactivate Aerator   ---------------------------
-----
   If hour = 1  Or hour = 2 Then
       High FILTER
       fltr = 1
   Else
      If hour = 7  Or hour = 8 Then
         High FILTER
         fltr = 1
      Else
         If hour = 13  Or hour = 14 Then
            High FILTER
            fltr = 1
         Else
            If hour = 19 Or hour = 20 Then
               High FILTER
               fltr = 1
            Else
              Low FILTER
               fltr = 0
```

```
            EndIf
         EndIf
      EndIf
   EndIf

' ------------------------------  Activate pH Meter  ----------------------------------
-------

   If pH_METER <= 6.5 And pH_METER_FLG = 1 Or pH_METER >= 8.1 And
pH_METER_FLG = 1 Or DAY_CTR = 14 And pH_METER_FLG = 1 Then
      DAY_CTR = 0
      PUMP_FLG = 1
      pH_METER_FLG = 0
      PUMP_CHK = 1
      VALVE_CHK = 0
      High PUMP
      pmp = 1
   EndIf

   If PORTE.0 = 1 And PUMP_FLG = 1 Then
      PUMP_FLG = 0
      VALVE_FLG = 1
      PUMP_CHK = 0
      VALVE_CHK = 1
      Low PUMP
      High VALVE
      pmp = 0
      Vlve = 1
   EndIf

   If PORTE.1 = 1 And VALVE_FLG = 1 Then
      VALVE_FLG = 0
     pHM_CTR = 0
      PUMP_CHK = 0
      VALVE_CHK = 0

      Low VALVE
      Vlve = 0
      GoSub onchlorine
   EndIf

 GoTo MAIN
 End
```

```
'=============================================================
=
'=============================================================
=
TO_SCREEN:
  GoSub   getx
  Print At 1,1,"  AQUARIUM STATUS   "
  Print At 2,1, " ",DEC2 hour, ":", DEC2 minute, ":", DEC2 second ," DAY
CNT=",DEC2 DAY_CTR
  Print At 3,1, " pH = ",DEC2 pH_METER

  Select Case Lamp
  Case 0
  Print At 4,1," L=",1
  Case 1
  Print At 4,1," L=",2
  EndSelect

  Select Case pH_METER
  Case 0 To 6.5
    Print At 3,12, " ACIDIC  "
  Case 6.6 To 8
    Print At 3,12, " NEUTRAL "
  Case 8.1 To 9
      Print At 3,12, " BASE    "
  Case 9.1 To 10
    Print At 3,12, " BASE    "
  EndSelect

  Select Case pmp
    Case 0
    Print At 4,5,"  P=",1
    Case 1
    Print At 4,5,"  P=",2
  EndSelect

    Select Case Vlve
    Case 0
    Print At 4,10,"  V=",1
    Case 1
    Print At 4,10,"  V=",2
  EndSelect
```

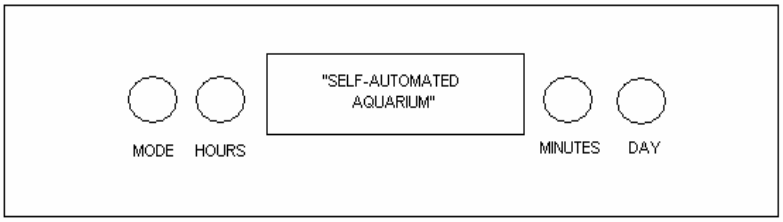
```
   Select Case fltr
   Case 0
   Print At 4,15,"  F=",1
   Case 1
   Print At 4,15,"  F=",2
  EndSelect

  Return
'-----------------------------------------------------------------------------------------------
-
MENU_SET:
  Select Case settings
   Case 2
    Print At 2,1, "     ",DEC2 hour, "Hr ", DEC2 minute,"Min"
    Print At 1,1, "   [Time Setting]   "
    'print at 3,1, "                    "
        DelayMS 150
   Case 3
    Print At 2,1, "     FISH = ",DEC2 FISH
    Print At 1,1, "   [FISH COUNTER]   "
        DelayMS 250
   Case 4
    Print At 2,1, "   DAY COUNTER = ",DEC2 DAY_CTR
    Print At 1,1, " DAY COUNTER SETTING"
        DelayMS 250
   Case 5
    If onetime = 0 Then
     onetime = 1
     x = 1
    EndIf
    Print $fe, 1
    on_screen = 1
    settings = 1
    onetime = 0
    Print $FE, $0C
        DelayMS 250
   End Select
  DelayMS 100
GoTo MAIN
'-----------------------------------------------------------------------------------------------
-
MENU_UUR:
  If settings = 2 Then up_hour = hour
```

```
  Inc up_hour
  If up_hour >= 24 Then up_hour = 0
  If settings = 2 Then hour = up_hour
  GoTo MENU_SET
MENU_MINUUT:
  If settings = 2 Then
    Inc minute
    If minute > 60 Then minute = 0
  EndIf
  GoTo MENU_SET
'-------------------------------------------------------------------------------------------
-
MENU_DAY_COUNTER:
  If settings = 4 Then
    Inc DAY_CTR
    EWrite 1,[DAY_CTR]
   EndIf

  If DAY_CTR >= 31 Then
    DAY_CTR = 0
    EWrite 1,[DAY_CTR]
  EndIf
  GoTo MENU_SET
'-------------------------------------------------------------------------------------------
-

fish_counter:
  If settings = 3 Then
    Inc FISH
    EWrite 0, [FISH]
    If FISH > 10 Then FISH = 0
    EWrite 0, [FISH]
  EndIf
  GoTo MENU_SET
'-------------------------------------------------------------------------------------------
-

GET_TIME:
    second = second + 1
    DelayMS 450
        If second = 60 Then
          minute=minute + 1
          second = 0
    EndIf
```

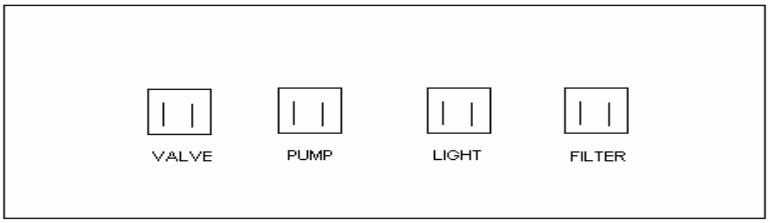
```
   If minute = 60 Then
   FEEDER_FLG = 1
   pH_METER_FLG = 1
   FOOD_CTR = FISH
   minute=0
        hour = hour + 1
   EndIf


   If hour=24 Then
      DAY_CTR = DAY_CTR + 1
       EWrite 1,[DAY_CTR]
   hour   = 0
   minute = 0
   second = 0
   EndIf
   Return
'-------------------------------------------------------------------------------------------------
-
onfeeder:
   If FOOD_CTR <= 0 Then
   FOOD_CTR = 0
   High feeder_Off
   Low Feeder_On
   FEEDER_FLG = 0
   EndIf

   FOOD_CTR = FOOD_CTR - 1
   High Feeder_On
   Low feeder_Off
   DelayMS 1000
   High  feeder_Off
   Low Feeder_On
   DelayMS 1000
   second = second + 2

   Return
'-------------------------------------------------------------------------------------------------
-
onchlorine:

   High CHLORINE
```

```
'-------------------------------------------------------------------------------------------
-
onchlorine2:

    DelayMS 5000
    Low CHLORINE
    second = second + 5
    Return
'-------------------------------------------------------------------------------------------
-

'-------------------------------------------------------------------------------------------
-
```

APPENDIX I
USER'S MANUAL



FRONT PANEL



BACK PANEL

OPERATING INSTRUCTIONS

1. Press "MODE" button
2. Set the current time setting by HOURS by pressing "HOURS"
3. Press "MODE" to confirm hours setting.
4. Set the current time setting by minutes by pressing "MINUTES"
5. Press "MODE" to confirm minutes setting.
6. Input number of fish by pressing "DAY" button
7. Press "MODE" to confirm day setting.
8. View the settings and aquarium status on the LCD display.

TROUBLESHOOTING

Preliminary checks:

1. Check for loose, broken cords or soldered wires.

2. Check for loosely connected cord plugs to the power.

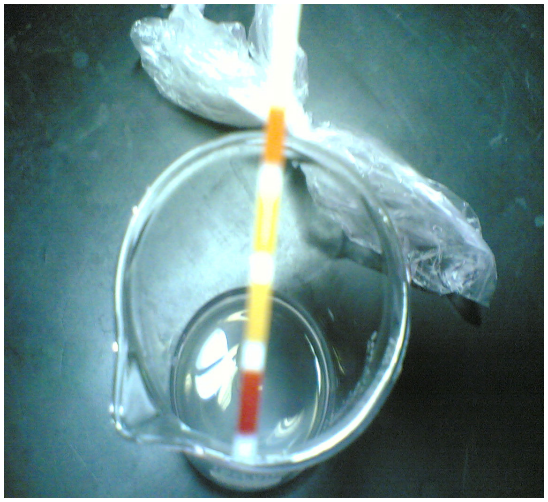
- **Filtering device is not functioning**
    - Make sure that filter device power cord is plugged on the proper outlet of the aquarium back panel.
    - Check if the filtering device is running by touching it. If there is no vibration, try connecting the power cord to other power outlets.
- **No Display on LCD**
    - Try restarting the system by reconnecting the power cord of the aquarium system to the power outlet.
    - Try pressing the "MODE" button.
- **Pump motor is not functioning**
    - Make sure that pump motor power cord is plugged on the proper outlet of the aquarium back panel.
    - Check if the pump motor is running by touching it. If there is no vibration or noise, try connecting the power cord to other power outlets.

- **Fluorescent Lamp is blinking**
    - Locate the LDR and adjust its location away from the lamp.
    - Check for loose or broken wire connection of the LDR.
- **Feeder motor stops running**
    - Check the feeder device if it has a pellet stuck inside the container.
    - Adjust the motor by pulling the lever and try to locate for stuck pellet.
- **Dechlorination device does not function.**
    - Check the wiring of the device for loose or broken connection.
    - Check if the syringe is empty. If it is empty, refill it by placing the dechlorination liquid in a container and place the liquid near the mouth of the syringe. Gently push the refill button inside the aquarium system and wait until the syringe is full again.

APPENDIX J
pH paper representation of values

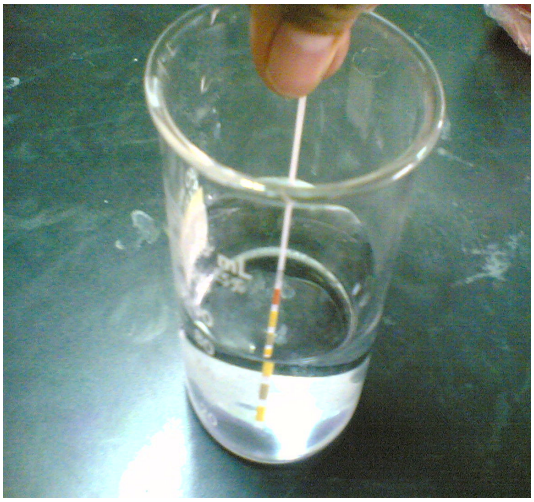
Ajax Finechem
Product Code 2401-100
pH-Sticks 0-14
100 colour-fixed indicator sticks
0 1 2 3 4 5 6 7
AJAX FINECHEM
Ajax Finechem
Dip in - read off.
If test solution is weakly buffered leave test stick in solution until colour no longer changes.
7 8 9 10 11 12 13 14

pH Paper Chart

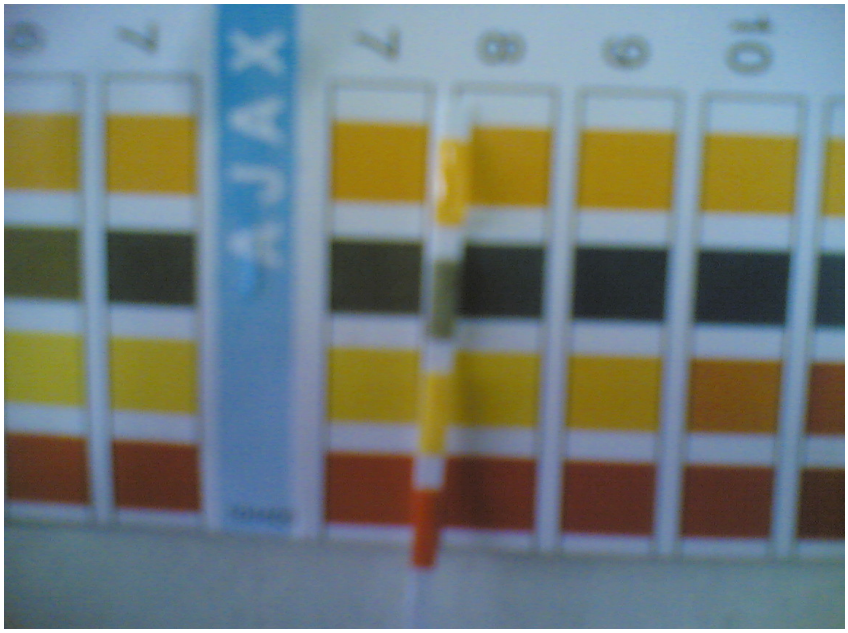


Test for Vinegar Solution

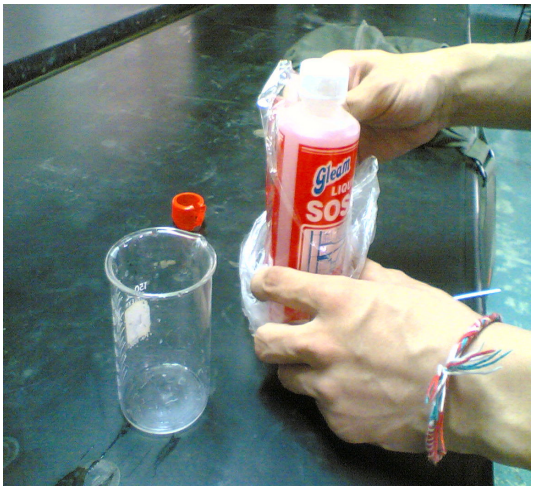
pH Test Results for Vinegar



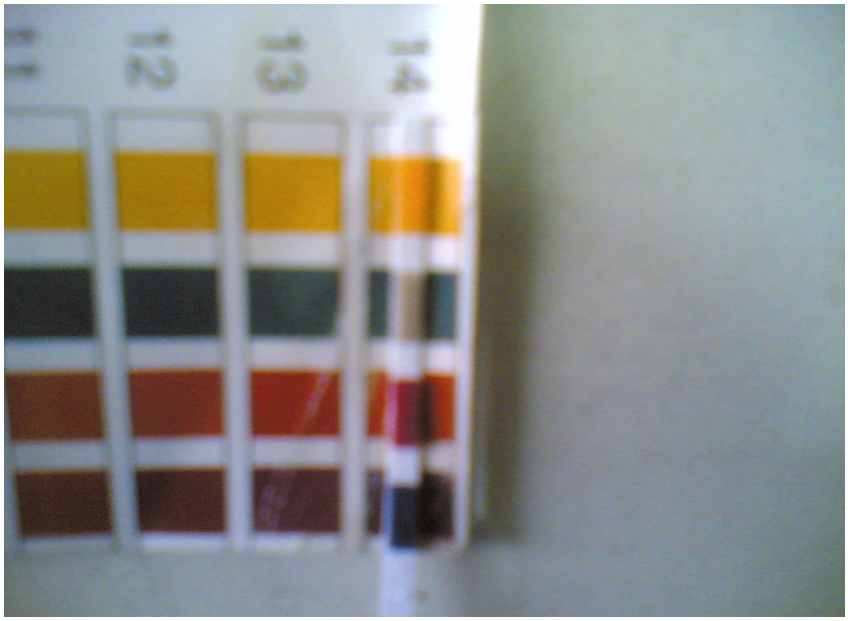
Test for Pure Water Solution



pH Test Results for Pure Water



Test for Liquid Sosa Solution



pH Test Results for Liquid Sosa